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NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstract 14109.

13614 (ORNL-3904(Rev.3)) CUMULATIVE INDEXES TO THE ANALYTICAL CHEMISTRY DIVISION ANNUAL PROGRESS REPORTS, 1964-1968. Raaen, Helen P.; Klein, Ann S. (eds.) (Oak Ridge National Lab., Tenn.). Feb. 1969. Contract W-7405-eng-26. 158p. Dep. CFSTI.

13615 (UVVVR-1) TRACE CONSTITUENTS DETERMINATION IN NUCLEAR GRADE URANIUM. A Bibliography. Svoboda, V.; Vavra, S.; Vockova, J. (Institute for Research, Production and Uses of Radioisotopes, Prague (Czechoslovakia)). 1968. 150p. Dep.

Nine hundred references on analytical methods for determination of trace impurities in uranium, published from 1956 through the first half of 1966 are presented. The papers are listed in alphabetical order by the author's name. (M.C.G.)

Chemical Procedures

13616 (CEA-CONF-1116) POLAROGRAPHIC DETERMINATION OF PLUTONIUM(V) IN A NONCOMPLEX MIXTURE. [Guichard, C.] [nd]. 11p. (In French). (CONF-680946-1). Dep.

From 3rd Conference on Analytical Chemistry, Warsaw, Poland.

A polarographic determination of Pu(V) from Pu(VI) in 0.1N perchloric acid was developed. The method may be applied to determination of Pu in amounts ≥10 mg/l with 2 to 3% precision. Iron and uranium were found to interfere. Thermodynamic data on the oxidation-reduction reactions and polarograms are included. (J.G.B.)

13617 (CEA-CONF-1163) APPLICATION OF PAPER CHROMATOGRAPHY TO MEASUREMENT OF TRACE ELEMENTS IN GEOLOGICAL MATERIAL. Agrinier, H. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). [1966]. 19p. (In French). (CONF-681205-1). Dep.

From National Conference on Measurement of Elements Occurring in Traces in Rocks, Nancy, France.

Trace amounts of Co, Cu, Nb, Ni, Pb, U, and Zn in geological materials were separated by paper chromatography and subsequently determined by chemical and physical means. Advantages of the method are its flexibility, sensitivity, and rapidity. (J.G.B.)

13618 (CEA-CONF-1176) DETERMINATION OF TRACES OF IRON, NICKEL, AND CHROMIUM IN SOLUTIONS OF PLUTONIUM NITRATE WITHOUT PRIOR SEPARATION BY ATOMIC ABSORPTION SPECTROPHOTOMETRY. Ganivet, M.; Benhamou, A. (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires). [1968]. 21p. (In French). (CONF-681038-1). Dep.

From 12th Conference on Analytical Chemistry in Nuclear Technology, Gatlinburg, Tenn.

A rapid method for the determination of traces of Fe, Ni, and Cr in aqueous solutions of plutonium nitrate by atomic absorption spectrophotometry without prior separation of plutonium is described. It is possible to determine Fe, Ni, and Cr in concentrations of 50 to 1500 ppM in solutions containing up to 100 g/l Pu. It was found that the presence of Pu decreases or suppresses the effects of interference among the three elements being determined. (tr-auth)

13619 (CEA-CONF-1182) APPLICATION OF EMISSION SPECTROSCOPY TO THE DETERMINATION OF 19 TRACE AND MAJOR ELEMENTS IN THE SOIL, THE VARIOUS GRANULAR FRACTIONS AND SOIL EXTRACTS. Saas, A.; Grauby, A. (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires). [nd]. 24p. (In French). (CONF-681205-3). Dep.

From National Conference on Measurement of Elements Occurring in Traces in Rocks, Nancy, France.

Studies were made on the chemical composition of soils, some diverse granulometric fractions, and some extracts of soils by arc spectrography. However, the preparation of the standards and of the samples was quite delicate in view of the diversity of the soils and the large variation of tracers. Nevertheless, the method gave certain evidence concerning a number of phenomena chemical bound to the pedogenesis of the stable elements and also uncovered some information in the course of the study of evolution on the probable dynamics of the radioisotopes and permitted a guide to be made on the study about some phenomena, such as the accumulations, the lixiviations, the formation of organomineral complexes, and also the action of the conditions of medium on the chemical and biochemical phenomena. (P.C.H.)

13620 (CEA-R-3641) POLAROGRAPHIC STUDY OF THE ELECTROCHEMICAL PROPERTIES OF PLUTONIUM. Guichard, Claude (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Dec. 1968. 100p. (In French). Dep.

The behavior of the different oxidation states of plutonium were studied using a falling drop mercury electrode in a noncomplexing medium: dilute perchloric acid. In this medium it is possible to carry out the polarographic determination of plutonium using the reduction step situated at −0.54 V/SCE, which corresponds to the passage from the oxidation state. The modifications brought about by a complexing ion, acetate, were observed and interpreted. The existence of two plutonium(IV) acetic complexes was shown; one is a polymerized substance. (auth)

13621 (EUR-4194) ON QUANTITATIVE ANALYSIS OF HIGH BOILING POLYPHENYL MIXTURES IN THE FIELD ION MASS SPECTROMETER. Final Report. Beckey, H. D.; Hilt, E.; Krone, H. (Bonn Univ. (West Germany). Institut fuer Physikalische Chemie). Apr. 2, 1968. Contract 265-66-4 ORGD. 32p. (In German). Dep.

The possibilities of field ion mass spectrometry for quantitative analysis of high boiling polyphenyl mixtures were investigated. As a result field ionization fits well the requirements of the group analysis of polyphenyl mixtures, since the mass spectra are very simple (no fragments with relative intensities >1%) and the field ionization probabilities of the different polyphenyls are equal within limits of accuracy. Difficulties are connected with sample inlet to the mass spectrometer ion source. When using a high temperature gas inlet system remarkable thermal decomposition was observed. The vaporization of samples directly from a crucible into the ion source, which finally was applied, had to be combined with ion detection by a photoplate integration technique. (auth)

13622 (EURFNR-567) SENSITIVE DIRECT DETERMINATION OF OXYGEN IN GASES AND LIQUID METALS FOR TECHNICAL APPLICATIONS AT HIGH TEMPERATURES. Sundermann, H.; Wagner, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorbauelemente). Translation of report KFK-819. 39p. Dep. CFSTI.

Work performed under United States–Euratom Fast Reactor Exchange Program.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 2177.

13623 (LA–4061) SPECTROPHOTOMETRIC DETERMINATION OF NEPTUNIUM. Bryan, R. G.; Waterbury, G. R. (Los Alamos Scientific Lab., N. Mex.). Dec. 2, 1968. Contract W-7405-eng-36. 8p. Dep. CFSTI.

Neptunium is measured spectrophotometrically as the Arsenazo III complex after separation from plutonium and impurity elements by liquid-liquid extraction. Uranium, if present as an impurity, is removed first by extraction from 4M hydrochloric acid solution into tri(iso-octyl)amine (TIOA)-carbon tetrachloride, while neptunium and plutonium are stabilized in their nonextractable (IV) and (III) oxidation states, respectively, by iron(II) and ascorbic acid. Then neptunium(IV) is extracted from 8M hydrochloric acid into TIOA-xylene and back extracted into 0.1M hydrochloric acid. The neptunium-Arsenazo III complex is formed in 6.1M hydrochloric acid, and the absorbance is measured at a wavelength of 665 mμ. Relative standard deviations range between 7.2 and 1.1% in measuring 8.5 to 330 ppM of neptunium in 200-mg samples. Of 45 different elements tested, only palladium, thorium, uranium, and zirconium cause serious interference, but only if present in concentrations greater than 0.8%. Hydrofluoric acid and nitric acid cause low results unless removed by volatilization. The method tolerates the intense radioactivity from quantities of ^{238}Pu as large as 100 mg. (auth)

13624 (TT–67-51409/4, pp 66-8) THE DETERMINATION OF TRACE AMOUNTS OF URANIUM IN WATER. Berdnikov, A. I. Translated from Gig. Sanit., 32: No. 10, 57-8(Oct. 1967).

The fluorescence method was used for the determination of trace amounts of U in water. However, the determination of U by this method must be preceded by its separation from any interfering elements. Various methods were used for this purpose. The results showed that the U content in water bodies of the Moscow region started at 0.34×10^{-6} g/l. The concentration of U was somewhat higher in waters with a higher content of mineral residue. The results were in agreement with the literature. (P.C.H.)

13625 DIFFERENTIAL KINETIC ANALYSIS OF ALKALINE EARTH IONS USING STOPPED-FLOW SPECTROPHOTOMETRY. Pausch, J. B.; Margerum, Dale W. (Purdue Univ., Lafayette, Ind.). Anal. Chem., 41: 226-32(Feb. 1969).

Exchange reactions between Pb(II) and the alkaline earth complexes of trans-1,2-diaminocyclohexane-N,N,N',N'-tetraacetate (CyDTA) proceed at sufficiently different velocities to permit the kinetic determination of mixtures of Mg, Ca, Sr, and Ba. The rate-determining step with each complex is its reaction with hydrogen ion. Ultraviolet absorbance of $PbCyDTA^{2-}$ is used to monitor the reaction but there is no kinetic dependence on Pb(II). Reaction rate constants are in the ratio of 1:6.5:96:1660 for Mg:Ca:Sr:Ba. The determinations are rapid and free of interference from other metal ions. (auth)

13626 DIFFERENTIAL KINETIC ANALYSIS OF THE METALLIC ELEMENTS. Margerum, Dale W.; Pausch, J. B.; Nyssen, G. A.; Smith, Gregory F. (Purdue Univ., Lafayette, Ind.). Anal. Chem., 41: 233-8(Feb. 1969).

Qualitative and quantitative analysis of mixtures of metal ions is achieved by observation of the rate of reaction of the metal–CyDTA (trans-1,2-diaminocyclohexane-N,N,N',N'-tetraacetate) complexes with acid or with an exchanging metal ion. Kinetic data are reported for more than 30 metal ions. The reactions of the CyDTA complexes are first order in metal–CyDTA, first order in hydrogen ion, and independent of other metal ions. The rate constants vary by a factor of 10^{12} and qualitative analysis is achieved by the detection of absorbance–time signals at various time scans (msec to min) and acidities (10^{-3}M to 1M $[H^+]$). Each metal or group of metals is observable at a specified combination of acidity and time scan. The resulting absorbance–time signals give quantitative determinations of metal ions down to 10^{-6}M with an accuracy of 10% or better. Analysis of mixtures of lanthanides, transition metals, group II and group III metals is possible. (auth)

13627 DETERMINATION OF NONIONIC SURFACTANTS BY ATOMIC ABSORPTION SPECTROPHOTOMETRY. Sheridan, J. C.; Lau, E. P. K.; Senkowski, B. Z. (Hoffmann-La Roche, Inc., Nutley, N. J.). Anal. Chem., 41: 247-50(Feb. 1969).

A quantitative method for the rapid determination of nonionic surfactants is described. The surfactant is precipitated as a heteropoly phosphomolybdic acid–barium complex and the molybdenum in the supernatant solution is assayed by atomic absorption. Optimum conditions for the analysis of high levels of molybdenum in the presence of high levels of barium were determined. The effect of other cations on the solution was determined. (auth)

13628 DETERMINATION BY ATOMIC ABSORPTION OF MOLYBDENUM, RUTHENIUM, PALLADIUM, AND RHODIUM IN URANIUM ALLOYS. Scarborough, J. M. (Atomics International, Canoga Park, Calif.). Anal. Chem., 41: 250-4(Feb. 1969).

The feasibility of determining Mo, Ru, Pd, and Rh in uranium alloys by atomic absorption spectrometry was investigated. The mutual interference of the four elements which is normally a complicating factor in the determination of these elements by atomic absorption was eliminated by the presence of uranium. A procedure for the analysis of uranium fissium is presented. (auth)

13629 DETERMINATION OF OXYGEN-TO-URANIUM RATIOS IN HYPO- AND HYPERSTOICHIOMETRIC URANIUM DIOXIDE AND TUNGSTEN–URANIUM DIOXIDE. Schaefer, E. A.; Hibbits, J. O. (General Electric Co., Cincinnati). Anal. Chem., 41: 254-9(Feb. 1969).

Several methods for the determination of oxygen-to-uranium ratios in hypo- and hyperstoichiometric UO_2 were developed and/or evaluated, using NBS 950a (U_3O_8) and uranium metal as standards. These methods include (a) oxidation to U_3O_{8+Y}, (b) a nitric acid dissolution procedure, followed by oxidation to U_3O_{8+N}, (c) an oxidation–reduction procedure, whereby the sample is first oxidized (in case the material is hypostoichiometric), then reduced to $UO_{2.00}$, (d) direct reduction with hydrogen of (hyperstoichiometric UO_2) to $UO_{2.00}$, and (e) hydriding, whereby the free uranium metal in hypostoichiometric UO_2 is first converted to UH_3 and the hydrogen subsequently determined. In addition, moisture was determined on a number of samples in order to evaluate its effect on the oxygen-to-uranium ratios obtained using the above methods. In general, the accuracies obtained are within the expected accuracies of the procedures used. Where applicable, the methods were applied to $W-UO_{2+X}$ samples, using UO_2 control specimens to evaluate the accuracy of the results obtained. (auth)

13630 STANDARDS FOR A PRACTICAL SCALE OF pD IN HEAVY WATER. Paabo, Maya; Bates, Roger G. (National Bureau of Standards, Washington, D. C.). Anal. Chem., 41: 283-5(Feb. 1969).

The glass electrode was found to respond to deuterium ion in heavy water solutions as well as to hydrogen ion in ordinary water. Furthermore, the glass-calomel pH assembly is useful for practical measurements of pD in heavy water. Several standard reference solutions for pD are needed, however, as the response of individual glass electrodes is not constant over the entire useful pD range. A suitable phosphate solution (pD 7.428 at 25°C) composed of KD_2PO_4 and Na_2DPO_4 (each 0.025 molal) was established in earlier work. This reference was supplemented by two other useful buffer solutions, namely 0.05m KD_2 citrate (pD 4.293 at 25°C) and a mixture of $NaDCO_3$ and Na_2CO_3 (each 0.025 molal) which has a pD of 10.736 at 25°C. Values were assigned at 10 temperatures from 5 to 50°C. The conventional pD scale fixed by these three standards was shown to have a satisfactory internal consistency. (auth)

13631 ILLUSTRATIONS OF HETEROGENEITY IN PHLOGOPITE, FELDSPAR, EUXENITE, AND ASSOCIATED MINERALS. Rimsaite, J.; Lachance, G. R. (Geological Survey of Canada, Ottawa). pp 209-29 of International Mineralogical Association. Naidu, P. R. J. (ed.). New Delhi, Mineralogical Society of India, 1966.

From International Mineralogical Association, Fourth General Meeting, New Delhi, India. See CONF-641225.

Heterogeneity in natural minerals is a very common phenomenon as a result of changes in physical-chemical conditions during mineral growth and/or subsequent alteration. Several examples of heterogeneity are described on the basis of microscopic, x-ray diffraction, and electron microprobe analyses. These consist of: (1) zoned phlogopite; and mica containing oriented inclusions and crusts; (2) "antiperthitic" and lamellar plagioclases; and associated biotite and opaque minerals; (3) fresh and altered euxenite; and inclusions in associated feldspar. The differences in chemical composition between various mineral varieties in zoned phlogopites, in "antiperthitic" and lamellar plagioclases, in ilmenite-hematite grains, and multicolored euxenite were studied. The concentration of iron in zoned phlogopites may increase by a factor of four from the beginning (center) to the end of crystallization (rim), and in some phlogopites potassium is absent in the outermost portion of the rim. "Antiperthitic" plagioclase is relatively homogeneous labradorite-andesine (An_{15-52}) with inclusions of potassium feldspar, while lamellar plagioclase consist of lamellae ranging in composition from An_5 to An_{70}, and of alkali feldspars. The concentrations of uranium and lead show erratic variations in the altered euxenite. (auth)

13632 INTERNATIONAL MINERALOGICAL ASSOCIATION. Papers and Proceedings of the Fourth General Meeting, New Delhi, December 15–22, 1964. Naidu, P. R. J. (ed.). IMA

Volume, 1966. New Delhi, Mineralogical Society of India, 1966. 259p. (CONF-641225).

Separate abstracts were prepared for four of the fifty-one papers presented. (D.H.M.)

For abstracts of individual papers see: 13631, 13633, 13885, and 13886.

13633 ABUNDANCE AND SIGNIFICANCE OF SOME MINOR ELEMENTS IN CARBONATITIC CALCITES AND DOLOMITES. Quon, Shi H.; Heinrich, E. Wm. (Univ. of Michigan, Ann Arbor). pp 29-36 of International Mineralogical Association. Naidu, P. R. J. (ed.). New Delhi, Mineralogical Society of India, 1966. From International Mineralogical Association, Fourth General Meeting, New Delhi, India. See CONF-641225.

Some 154 samples of carbonates (calcite, dolomite, and ankerite) from 17 different carbonatite deposits in the United States, Canada, Europe, and Africa were analyzed by quantitative spectrographic methods for Ba, Sr, Mg, Fe, Al, and Si. All calcites from geologically unquestionable carbonatites are notably enriched in barium and strontium by a factor 8 to 800× for barium and 26 to 170× for strontium over sedimentary calcites. Strontium always exceeds barium by a factor ranging from 6.5 to 55×. Among the three carbonate species, early calcite always contains the most barium and strontium; dolomite, the least; ankerite has intermediate amounts. Both elements decrease in amount with decreasing relative age of the carbonate species in a paragenetic sequence. Early carbonatitic calcites, shown to be homogeneous, contain an average of 0.68% Mg, with six samples containing over 2% Mg. Higher magnesium contents previously attributed to carbonatitic calcites stem in part from exsolved dolomite. Manganese is selectively and markedly enriched in ankerites. Iron usually exceeds manganese in calcites and dolomites. Aluminum and silicon are present in all samples. In a few cases the amounts are of a magnitude that suggests the possible presence of submicroscopic impurities. Their constant presence in demonstrably homogeneous material, however, is difficult to explain. High barium and strontium contents thus serve to identify carbonitic calcites. No systematic variation in these two elements was found to distinguish carbonatites of one province from those of another. (auth)

13634 DETERMINATION OF OXYGEN IN REFRACTORY OXIDES. MacDougall, Carolyn S.; Smith, Maynard E.; Waterbury, Glenn R. (Los Alamos Scientific Lab., N. Mex.). Anal. Chem., 41: 372-4(Feb. 1969).

An inert-gas fusion–gravimetric determination of oxygen in refractory oxides is described. Mixing graphite with the oxide and pelletizing provided intimate contact of the reacting species and eliminated the need for a platinum bath. The pellet was heated from a temperature of 1000 to 2000°C in 20 min and the maximum temperature maintained for 1 hr. The absorption tubes were weighed by an established gravimetric method. Carbon dioxide was produced, as well as CO, and was measured and included in the calculations. Samples of ThO_2, U_3O_8, PuO_2, and $(U_{0.8}Pu_{0.2})O_2$ were analyzed and the relative standard deviations obtained were 0.1 for both ThO_2 and U_3O_8 and 0.2 for both PuO_2 and $(U_{0.8}Pu_{0.2})O_2$. (D.H.M.)

13635 GRAVIMETRIC DETERMINATION OF COPPER WITH DIHYDROXYMALEIC ACID. Sadzhaiya, N. Tr. Tbilis. Gos. Pedagog. Inst., 19: 379-85(1966). (In Russian).

This method can be used for determining Cu in neutral or weakly acidic medium, or for separating Cu from Co, Mn, As, and Mo. Alternatively, Cu can be determined by an indirect method by reducing Cu^{2+} to Cu^{+} with $(NH_4)_2SO_4 \cdot FeSO_4 \cdot 6H_2O$ in weakly acidic medium (0.5 to 0.7N in H_2SO_4) in the presence of KSCN, and titrating the $Fe(SCN)_3$ (produced in amount equivalent to the Cu) with dihydroxymaleic acid solution. The latter method is suitable for determining Cu in ores after its separation from accompanying metals by precipitation with thiosulphate. (Anal. Abstr.)

13636 STUDIES ON SPECTROCHEMICAL ANALYSIS OF RARE EARTH ELEMENTS. I. EFFECTS OF COEXISTENT COMPONENTS FOR SPECTROGRAPHIC ANALYSIS OF RARE EARTH ELEMENTS BY ROTATING ELECTRODE. Osumi, Yasuaki; Kato, Akihiko; Higashi, Kunishige; Miyake, Yoshizo (Government Industrial Research Inst., Osaka). Bunseki Kagaku, 18: 35-41(Jan. 1969). (In Japanese).

The spectral intensities of concerning elements were affected by the nature and concentration of coexistent components. Addition of elements having the ionization potentials lower than 6 eV increases the spectral intensities, and, especially, the coexistence of Cs, Na, Rb, and Ba remarkably increases the sensitivities. The optimum concentrations of the coexistent elements which give the highest intensity depend linearly on their ionization potentials. That is, the lower the ionization potentials of the coexistent elements, the higher their optimum concentrations. The addition of ethanol increases the spectral intensity and sensitivity of rare earth elements. (auth)

13637 STUDIES ON REAGENTS FOR NIOBIUM AND TANTALUM. IV. THE REACTION OF DIBROMOGALLIC ACID WITH NIOBIUM(V) AND TANTALUM(V) IN THE PRESENCE OF OXALIC ACID, TARTARIC ACID, AND EDTA. Ackermann, Gerhard; Koch, Siegfried (Institut fuer Anorganische und Analytische Chemie, Freiberg, Ger.). Talanta, 16: 288-92(Feb. 1969). (In German).

The reactions between niobium(V) or tantalum(V) and dibromogallic acid in the presence of auxiliary complexing agents were examined spectrophotometrically and electrophoretically. The ternary chelates $[NbO(H)RY]^{3-}$ and $[TaO_2ROx_2]^{6-}$ (H_3R = dibromogallic acid, Ox = oxalate, H_4Y = EDTA) were found. (auth)(UK)

13638 ANALYTICAL APPLICATIONS OF ALKYL PHOSPHORIC ACID ESTERS. V. Upor, Endre; Szalay, Jozsefne; Klesch, Katalin (Mecseki Ercbanyaszati Vallalat, Kovagoszollos, Hungary). Magy. Kem. Foly., 74: 438-40(Sept. 1968). (In Hungarian).

A photometric-extraction method for determination of small quantities of Sc in rock was developed. It is based on measurement of the light absorption of scandium complexes with Arsenazo (III) at a wavelength of 670 mμ in hydrochloric acid. The impurities were separated by precipitation with NaOH, with $H_2C_2O_4$, and by extraction with dibutyl phosphate. Scandium and thorium were determined together and separately. The method was used with various types of ores. (tr-auth)

13639 FLUORIMETRIC DETERMINATION OF SAMARIUM AND EUROPIUM IN AQUEOUS ACETONE SOLUTIONS BY COMPLEXING WITH β-DIKETONES AND ORGANIC BASES. Kononenko, L. I.; Tishchenko, M. A.; Vitkun, R. A.; Melent'eva, E. V. (Inst. of General and Inorganic Chemistry, Kiev). Zavod. Lab., 34: 1432-5(1968). (In Russian).

The fluorimetric determination of samarium and europium in aqueous acetone solutions by the utilization of complex compounds with thenoyltrifluoroacetone and 1,10-phenanthroline is reported. The sensitivity of the method was 7.5×10^{-3}% Sm_2O_3 and 7.5×10^{-4}% Eu_2O_3. (tr-auth)

13640 DEPOLYMERISATION OF ZIRCONIUM IN SPECTROPHOTOMETRY WITH ARSENAZO III. Pakalns, P. (Australian Atomic Energy Commission, Lucas Heights, New South Wales). Anal. Chim. Acta, 44: 73-83(Jan. 1969).

The preparation of depolymerized solutions from various zirconium salts in the cold and on boiling, the depolymerization of polymerized zirconium solutions, and the dissolution of precipitated zirconium hydroxide by hydrochloric acid, are described. The concentrations of the zirconium solutions are between 10^{-4} and 10^{-1} M. The minimum permissible concentrations of various acids are shown by depolymerization curves. Zirconium was determined by spectrophotometry with Arsenazo III in 8 N hydrochloric acid, and the interferences by sulfate, perchlorate, phosphate, fluoride, and nitrate are described. (auth)

13641 OSCILLOPOLAROGRAPHIC DETERMINATION OF INDIUM, LEAD, AND CADMIUM IN A SUPPORTING ELECTROLYTE CONTAINING CUPFERRON. Donoso, G.; Santa Ana V., M. A. (Univ. of Chile, Santiago). Anal. Chim. Acta, 44: 211-16(Jan. 1969).

In a supporting electrolyte containing phosphate buffer pH 7, 10^{-2} M sodium thiosulfate and 10^{-2} M cupferron, lead(II), cadmium(II), and indium(III) give reversible, sensitive, and well-defined incisions in the $dE/dt = f(E)$ curves (Q = 0.40, 0.45, and 0.52, respectively). The limit of detection is 2×10^{-6} M in each case and 2×10^{-6} to 5×10^{-5} M of each cation may be determined. There are few serious interferences. (auth)

13642 SPECTROPHOTOMETRIC DETERMINATION OF RUTHENIUM WITH 2,3-DIAMINOPYRIDINE. Ayres, Gilbert H.; Eastes, Danis T. (Univ. of Texas, Austin). Anal. Chim. Acta, 44: 67-72(Jan. 1969).

Ruthenium, in solution as its high oxidation states, and 2,3-diaminopyridine react in concentrated acetic acid to give an indigo–blue product having an absorption peak at 572 nm. The color develops at room temperature, and the method is not highly sensitive to the concentration of the reagent nor to the development time. The optimum concentration range, for measurement at 1.00-cm optical path, is about 1 to 6 ppM of ruthenium; the molar absorptivity is 1.2×10^4 l mole^{-1} cm^{-1}. A prior separation of ruthenium is necessary. Spectrophotometric methods established a 1 : 1 mole ratio in the color reaction. The product is predominantly in cationic form in acetic acid solution, and predominantly anionic in alkaline medium.(auth)

13643 ARSENAZO M: A NEW REAGENT FOR THE RARE EARTH ELEMENTS. Savvin, S. B.; Propistsova, R. F.; Strel'-

nikova, R. V. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Zh. Anal. Khim., 24: 31-8(Jan. 1969). (In Russian).

An analytical study was made of the lanthanum reactions with 13 reagents of the series of 2,7-bisazo derivatives of chromotropic acid containing one functional-analytical o-arsono-o'-hydroxyazo group. The most sensitive is arsenazo M indexed as o-[[1,8-dihydroxy-3,6-disulfo-7-[(m-sulfophenyl)-azo]-2-naphthyl] azo]benzenearsonic acid, reacting with lanthanum at pH 3 to 5; the molar extinction coefficient is $\epsilon = 86{,}000$ at $\lambda_{max\ MeR} = 640$ nm; the reaction is a contrasting one ($\Delta\lambda = 100$ nm); The molar extinction coefficients of the solutions of the arsenazo M complexes with other rare earth elements are within 73,000 to 86,000. Arsenazo M is of interest also for the determination of other elements (Cu, Sc, Pb, Ca, and others). The complex formation of arsenazo M with lanthanum and copper was studied. The complex composition is 1 : 1, the number of hydrogen ions evolved in the reactions is 2. A method is suggested for determining rare earth elements by means of arsenazo M in the presence of uranium. (auth)

13644 REZARSON AS A REAGENT FOR MOLYBDENUM. Lukin, A. M.; Petrova, G. S.; Kaslina, N. A. (All-Union Scientific-Research Inst. of Chemical Reagents and Specially Pure Chemicals, Moscow). Zh. Anal. Khim., 24: 39-42(Jan. 1969). (In Russian).

Rezarson (2,2',4'-trihydroxy-3-arsono-5-chloroazobenzene) was studied as a reagent for molybdenum. It was found that the optimum medium is a 50% aqueous-ethanol medium 0.5N with respect to HCl. The stoichiometric ratio of the components (R : Mo = 1 : 1), the molar extinction coefficients of the reagent 1.57×10^3 and of the complex compound 1.34×10^4 and the equilibrium constant of the complex forming reaction 2.2×10^6 were determined. A method was developed for determining molybdenum in steel. (auth)

13645 METHODS OF SEPARATING ELEMENTS OF VARIOUS OXIDATION STATES. Tserkovnitskaya, I. A.; Luginin, V. A. (Leningrad State Univ.). Zh. Anal. Khim., 24: 54-68 (Jan. 1969). (In Russian).

A brief review is given on the methods of direct quantitative determination of elements of various oxidation states in the presence of other elements. A masking agent is used and methods of preliminary separation of compounds of various acidity are followed by quantitative determination. Tabulated data are given on the extraction of various elements by paper chromatography, distributive chromatography in columns, electrophoresis, and methods of extraction of variously charged ions by acid organophosphoric extracting agents. (172 references). (R.V.J.)

13646 USE OF ARSENAZO-III IN U DETERMINATION IN SOILS AND BIOLOGICAL MEDIA. Prister, B. S.; Zubach, S. S. Radiokhimiya, 10: 743-6(1968). (In Russian).

Changes introduced into the P. N. Palei et al. (Radiokhimiya, 3: 2(1961)) method of U determination in soils and biological media by Arsenazo(III) are described. Correlated data are given on the results obtained by R. N. Palei and by the improved method. Tabulated data are also given on the results obtained by extraction-photometric and luminescence methods of U determination in plants, vegetables, milk, and soil. (R.V.J.)

Isotopic Procedures

13647 (HASL-202) DETERMINATION OF RADON PROGENY IN AIR FROM ALPHA ACTIVITY OF AIR SAMPLES. Thomas, Jess W. (New York Operations Office (AEC), N. Y. Health and Safety Lab.). Nov. 1968. 39p. Dep. CFSTI.

A simple, accurate set of three equations is derived for calculating the air concentration of radium A, radium B, and radium C. These equations are an improvement of the original Tsivoglou, Ayer, and Holaday equations because the air concentrations are given directly and the intermediate step of calculating the number of atoms of each isotope on the filter paper is unnecessary. Build up and decay equations, for the three isotopes, of various investigators are converted to the same terminology, compared, and checked for accuracy. Close agreement is found in all cases, except for a numerical error in the air concentration equation for RaC of Tsivoglou, Ayer, and Holaday. (W.H.K.)

13648 DETERMINATION OF PHOSPHATE IN WATER WITH ^{185}W. Hahn, Richard B.; Schmitt, Thomas M. (Wayne State Univ., Detroit). Anal. Chem., 41: 359-60(Feb. 1969).

A method was developed for determining phosphate in water samples by forming ^{185}W–molybdophosphoric acid complex, extracting it into an organic solvent, and then counting the extracted tungsten activity and relating the activity to the original phosphate concentration. The effect of the amount of tracer added on the activity of the extracted complex was studied; and data showed that the amount of ^{185}W activity in the final sample varied with the amount of ^{185}W tracer added in a continuous, linear manner. Several solvents were investigated and the most complete extraction, combined with the smallest extraction of interferences, and the smallest volume of organic reagent needed was obtained with 2-octanone. With this extractant, efficiency of extraction as measured with ^{32}P was about 85% in the ppB phosphate range, using 3 ml of 2-octanone per 100 ml of water. The method was successful for phosphate concentrations ranging from 10 ppB to 100 ppM. (D.H.M.)

13649 APPLICATION OF INTERRUPTED-ELUTION TO COMBUSTION RADIO GAS CHROMATOGRAPHY. Cacace, Fulvio; Perez, Giorgio (Univ., Rome). Anal. Chem., 41: 368-72 (Feb. 1969).

The interrupted-elution principle was used in the combustion radio gas chromatographic analysis of a mixture of cyclohexane-1,2-T and n-propanol-2, 3-T. The standard deviation for mixture 1 consisting of 22 runs was 0.024 and the percent error 3.10 and for mixture 2 with 21 runs the standard deviation was 0.04 and the percent error 1.93. Some drawbacks of the method are: relative short life of the combustion tube, caused by the passage of the purge gas, containing H_2, through both the oxidation and reduction sections; the loss of resolution, which becomes increasingly serious as the interruption period is extended; and the time required for the analysis is considerably longer than in the conventional flow technique and could prevent the application of the method to certain short-lived nuclides. The static activity measurements, permitted by the interruption of the elution offers a number of advantages, including high sensitivity, elimination of errors introduced in the conventional analysis by variations of the flow-rate, and the possibility of extending the counting time in order to reduce the statistical uncertainty associated with the radioactivity measurement. Still more important, the much longer residence time of each eluted peak within the furnace ensures a complete combustion of the tritiated compounds. (D.H.M.)

13650 AUTOMATED DETERMINATION OF TRACES OF MERCURY IN BIOLOGICAL MATERIALS BY SUBSTOICHIOMETRIC RADIOISOTOPE DILUTION. Ruzicka, J.; Lamm, C. G. (Technical Univ. of Denmark, Lyngby). Talanta, 16: 157-68 (Feb. 1969).

Solid samples (1 to 2 g) are burned in oxygen in a flask containing radiomercury in dilute hydrochloric acid, in which the non-active mercury to be determined is immediately absorbed. All mercury is subsequently extracted by dithizone in carbon tetrachloride and then re-extracted into dilute hydrochloric acid. This aqueous phase is analyzed automatically (AutoAnalyzer, 20 samples/hr). Liquids (up to 100 ml) are analyzed in a similar way but instead of being burned in oxygen are first oxidized with potassium permanganate in acid medium. Quantities between 2 and 0.00004 ppM Hg were determined in various materials. Results for international biological standards agreed well with values obtained by activation analysis: kale 0.159 ppM Hg (relative standard deviation 2%) and IAEA cereals 0.0435 ppM Hg (±5%). The method is far more simple and rapid than activation analysis and just as sensitive; it is therefore more suitable for routine work. About 100 samples can be analyzed per day. (auth)(UK)

13651 A MICRO QUANTITATIVE DETERMINATION OF TOTAL FATTY ACIDS IN BIOLOGICAL SAMPLES BY ESTERIFICATION WITH RADIOACTIVE METHANOL. Fischer, George A.; Kabara, Jon J. (Univ. of Detroit). Anal. Biochem., 25: 432-9(Oct. 24, 1968).

By the application of the isotope derivative technique with radioactive methanol, a procedure for measuring esterified and non-esterified fatty acids was devised. The present method is ideally suited to measuring large numbers of biological samples when total fatty acid content is required. The wide range of sample size, short time required for measurement, applicability to both free and esterified fatty acids, and possibility of computorized data processing make the present method a valuable supplement to gas-liquid chromatography. (auth)

13652 SUBSTOICHIOMETRIC ISOTOPE DILUTION ANALYSIS IN THE MICROGRAM AND SUBMICROGRAM RANGES BY PRECIPITATION REACTIONS ON FILTER PAPER. Krivan, V.; Weisz, H.; Klockow, D. (Univ., Freiburg i. B.). Anal. Chim. Acta, 44: 34-9(Jan. 1969). (In German).

A new microchemical variation of substoichiometric isotope dilution analysis by means of precipitation reactions on filter paper is described. The method is demonstrated for determinations of silver (precipitated as $^{110m}Ag_2S$) iron(III) {as $^{59}Fe_4[Fe(CN)_6]_3$}, and iodide (as $Ag^{131}I$). Amounts of 0.1 to 40 μg can be determined with satisfactory accuracy. Essential conditions for the application of the method are discussed. (auth)

13653 PROLYLHYDROXYPROLINE IN URINE: IMPROVED METHOD FOR DETECTING RADIOACTIVITY WITH A SCANNER

ON FULL SHEETS OF CHROMATOGRAPHY PAPER. Kibrick, A. C.; Power, H. L.; Sevendal, E.; Milhorat, A. T. (Inst. for Muscle Disease, Inc., New York). Anal. Biochem., 25: 40-5 (Oct. 24, 1968).

Construction and use of a simple scanning device are described for locating small amounts of radioactivity on large uncut filter papers used for chromatography and electrophoresis. With this device the use of autoradiographs is eliminated from the original method for determining urinary hydroxyproline on the principle of isotope dilution. The modified method is described, and eight results are reported for the recovery of added nonradioactive dipeptide. Percentage of recovery varied from 84.5 to 111% with an average of 98.4%. (auth)

Radiometric Procedures

13654 (DP-MS-68-9) USE OF GAMMA-NEUTRON REACTION FOR DETERMINING D_2O IN H_2O AND IN TRACING SOIL MOISTURE. Overman, R. F.; Corey, J. C.; Hawkins, R. H. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). May 15, 1968. Contract AT(07-2)-1. 13p. (CONF-680601-57). Dep. CFSTI.

From 14th Annual Meeting of the American Nuclear Society, Toronto, Ontario.

A nondestructive method was developed for determining deuterium by the (γ,n) reaction. The method was used to determine the D_2O extracted from river water and to locate D_2O in soil moisture studies. The gamma source was metallic ^{208}Tl produced from 4-Ci ^{228}Th. The thorium metal was electrodeposited into a bismuth matrix to avoid oxidation. A ^{24}Na source was also used in some of the experiments. (M.C.G.)

13655 (UCRL-14654(Rev.1)) ELEMENTAL ANALYSIS USING NEUTRON INELASTIC SCATTERING. Waggoner, James A.; Knox, Richard J. (California Univ., Livermore. Lawrence Radiation Lab.). Dec. 1, 1968. 47p. Dep. CFSTI.

The technique of elemental analysis by analysis of the γ rays resulting from the inelastic scattering of 14-MeV neutrons is described. This method is especially suitable for analysis of the major constituents of bulk samples such as planetary surfaces. Sample size, limits of sensitivity for Fe, Si, O, Mg, Al, Na, K, and Ca, detector resolution, shielding requirements, and geometrical effects are considered. An instrument designed for planetary surface analysis will be described as one possible application of this method. This instrument weighs about 15 pounds and includes a pulsed source of 14-MeV neutrons, a gamma ray detector, and a 512 channel pulse height analyzer as well as the necessary electronics. (auth)

13656 GAMMA PULSE HEIGHT DETERMINATION OF ^{238}Pu IN SOLID WASTES. Mershad, E. A.; Curtis, M. L.; Jarvis, J. Y.; Amos, W. R. (Mound Lab., Miamisburg, Ohio). Anal. Chem., 41: 384-8(Feb. 1969).

A procedure was developed for determining the amount of ^{238}P in wastes removed from glove boxes. For recovery purposes, ^{238}Pu-contaminated wastes consisting of ion exchange resins, paper, rags, polyethylene, glass, and metal were segregated into various categories, such as resin, combustibles, and noncombustibles, prior to removal from glove box lines. The material was packaged in ½-gal cans, removed from the glove box in polyethylene bags, and packaged in 1-gal cans. The cans were sealed and enclosed in polyethylene bags. Each, labeled with the appropriate category contained ^{238}Pu ranging from negligible quantities up to 10.3 g. The 100-keV photons from ^{238}Pu were counted by a gamma pulse height analysis procedure. The accuracy of the technique was dependent upon the quantity of isotope and type of waste materials in the package. A comparison of the gamma scan and calorimetry values of known quantities of isotope showed that the maximum deviation between the actual and theoretical values was 12.6%. The standard deviation varied from ±0.6 mg at the 16-mg level to ±18 g at the 10,32-g level. The method can also be used for glove box exhaust filters. (D.H.M.)

13657 RADIOISOTOPE X-RAY FLUORESCENCE SPECTROMETER WITH A HIGH-RESOLUTION SEMICONDUCTOR DETECTOR. ANALYTICAL SENSITIVITY FOR ELEMENTS IN LOW ATOMIC NUMBER MATRICES. Yamamoto, Sachio (Naval Radiological Defense Lab., San Francisco). Anal. Chem., 41: 337-42(Feb. 1969).

The analytical sensitivity of an x-ray fluorescence spectrometer utilizing a radioisotope exciter source and a high-resolution, lithium-drifted silicon detector was evaluated for elements in low atomic number matrices. The spectrometer system which was studied used ^{125}I as the exciter source and contained a 30-mm^2 detector with a resolution of 512 eV full-width at half-maximum (FWHM) at 6.40 keV. Known molybdenum samples ranging from 10 ng to 1 mg, and nickel samples ranging from 0.1 μg to 1 mg, were prepared and analyzed. It was found that the detection limit for molybdenum was 35 ng with a ca. 5-mCi exciter source; precision in the submicrogram range was 10 to 20%. The detection limit for nickel was considerably poorer and was found to be 1 μg for an exciter source strength of ca. 10 mCi. An examination of the various factors that affect the analytical sensitivity of the system showed that the sensitivity was limited primarily by poor detector geometry resulting from the small size of the high-resolution Si(Li) detector, and by background. A principal contributor to background was backscatter of the exciter source radiation by materials surrounding the source and detector. It was found that the radiation was being scattered mainly by air. (auth)

13658 RADIOMETRIC METHODS OF POTASSIUM DETERMINATION IN SOLUTIONS AND SOLIDS. I. METHODS BASED ON BETA ACTIVITY MEASUREMENTS. POSSIBILITY OF THE DETERMINATION OF SMALL AMOUNTS OF POTASSIUM. Zaduban, M.; Kupka, J. (Safarik Univ., Kosice, Czech. Institut fuer Bergbau und Gesteinsforschung, Kosice, Czech.). J. Radioanal. Chem., 2: 19-33(Jan. 1969). (In German).

The possibilities for the radiochemical assay of potassium in solid and liquid samples using a plastic well scintillation crystal or a flow counter are described. Amounts of potassium as small as 1 mg (0.02% of the sample) can be measured. For the assay the following possibilities are mentioned: using the known value of the total measuring efficiency, using the calibration curve $m_K = f(N)$, and the mutual comparison of the sample and the standard. Different factors influencing the measurement must be considered. The optimal conditions for radiometric analysis are suggested. (auth)

13659 RADIOMETRIC METHODS OF POTASSIUM DETERMINATION IN SOLUTIONS AND SOLIDS. II. METHODS BASED ON GAMMA ACTIVITY MEASUREMENTS WITH SCINTILLATION COUNTERS. Zaduban, M.; Kupka, J. (Safarik Univ., Kosice, Czech. Institut fuer Bergbau und Gesteinforschung, Kosice, Czech.). J. Radioanal. Chem., 2: 35-47(Jan. 1969). (In German).

The possibilities of the radiometric determination of potassium by measuring the γ-activity are described, using solid and liquid samples, and various methods. The selection of the criteria in the determination of the smallest possible amount of potassium is discussed on the basis of statistical results of the measurements (sensitivity of the method). Potassium in quantities of about 1 g can be determined radiometrically. It is particularly convenient to determine the cesium unit by the γ-spectrometric measurement of ^{137}Cs, and to measure the potassium content in ash, the dry residue of vegetable matter, animal organs, foodstuffs, etc., by this method. (auth)

13660 GRAIN SIZE EFFECT IN LOW-ENERGY GAMMA AND X-RAY SCATTERING. Holynska, B. (Academy of Mining and Metallurgy, Krakow). Spectrochim. Acta, Part B., 24: 85-93 (Jan. 1969).

Dependence on the energy of the primary radiation and on the content of heavy elements in light matrices was considered. It was found that the intensity of scattered radiation increases with increasing grain size. Such an effect was observed both for a pure matrix (sand) and for samples containing heavy elements (iron or barium). (auth) (UK)

13661 MEASUREMENT OF RADIOACTIVITY IN EFFLUENTS OF A GAS CHROMATOGRAPH. II. Cramer, W. A.; Houtman, J. P. W.; Piet, G. J.; de Boer, E. (Reactor Instituut, Delft, Netherlands). Int. J. Appl. Radiat. Isotop., 20: 129-30(Feb. 1969).

A new type of absorber (Int. J. Appl. Radiat. Isotop., 17: 97 (1966)) which avoids the difficulties associated with frequent exchanging of the absorbers and makes continuous activity measurement possible is described. Tests are described using $^{14}CO_2$ of known activity. The method of use is not only of value in combination with gas chromatographic separations, but can often be applied when continuous monitoring of the $^{14}CO_2$ content in gas streams is required, such as in metabolic studies. (UK)

13662 XENON IN CHONDRULES AND MATRIX MATERIAL OF CHONDRITES. Alexander, E. C. Jr.; Manuel, O. K. (Univ. of Missouri, Rolla). Geochim. Cosmochim. Acta, 33: 298-301 (Feb. 1969).

Analyses of xenon in two olivine–hypersthene chondrites showed that radiogenic xenon-129 resides in both the chondrules and in the matrix material. Radiogenic xenon-129 is more prominent in the chondrules, but the nonradiogenic xenon is more abundant in the matrix material. (auth)(UK)

13663 ANALYTICAL APPLICATION OF X-RAY RADIATION INDUCED BY RADIOACTIVE ISOTOPES. III. Vertes, Attila;

Beck, Ivan (Eoetvoes Lorand Tudomanyegyetem Fizikai-Kemiai es Radiologiai Tanszeke, Budapest). Magy. Kem. Foly., 74: 418-22(Sept. 1968). (In Hungarian).

Absorptive properties of x radiation induced by β particles in various targets were studied. It is shown that in specially selected targets it is possible to determine the composition of solutions and mixtures, with an order of error of 1 to 2%, using the simple method of resonance absorption. (R.V.J.)

13664 COMBUSTION ANALYSIS OF RADIOACTIVITY AND DENSITOMETRY OF PROTEIN IN POLYACRYLAMIDE GELS. McEwen, Bruce S. (Rockefeller Univ., New York). Anal. Biochem., 25: 172-80(Oct. 24, 1968).

A method is described for estimating the protein content and counting of tritium-labeled substances in polyacrylamide gels. Protein content is estimated by densitometry of amido black stained gels, and radioactivity is measured by combustion of gel slices in glass vials and counting at 35% efficiency in the same vials. (auth)

13665 X-RAY FLUORESCENCE MEASUREMENT OF SURFACE URANIUM ON OXIDIZED FUEL ELEMENTS. Schaefer, E. A.; Elliot, P. F.; Hibbits, J. O. (General Electric Co., Cincinnati). Contract AT(40-1)-2847. Anal. Chim. Acta, 44: 21-8 (Jan. 1969).

When a uranium nuclear fuel material clad with an Fe–25Cr–4Al–1Y alloy is tested in an oxidizing environment at elevated temperatures, uranium diffuses through the clad and deposits on the surface of the specimen. A method was developed whereby the amount of uranium per unit area on the surface of the specimen can be determined by x-ray fluorescence measurement. Synthetic specimens can be prepared by vapor-depositing uranium metal on Scotch tape and applying this tape to a solid piece of the alloy. The method described is accurate to ±5% relative and has a lower detection limit of about 30 μg U/(cm^2 × 150 μ). (auth)

13666 THEORETICAL DISCUSSION OF METHODS OF ELIMINATION OF MATRIX EFFECTS IN NON-DISPERSIVE X-RAY ANALYSIS. Lubecki, A. (Inst. of Nuclear Techniques, Krakow). J. Radioanal. Chem., 2: 3-18(Jan. 1969).

Theoretical consideration concerning some possibilities for the elimination of matrix effects in non-dispersive x-ray fluorescence and absorption analysis are discussed. The theoretical treatment is concerned with the following methods: double-channel absorption edge analysis, concentration increase and dilution method in fluorescence analysis, fluorescence-absorption method, emission-transmission method, fluorescence-Compton scattering method, and method of multicomponent analysis. On the basis of the derived formulas, nomographic methods of interpretation of the data are given. Using these methods it is possible to determine unambiguously the concentration of the relevant element. The formulas are also convenient for numerical interpretation. The introduction of the concept of "generalized sensitivity" allows the comparison of various radiometric methods. (auth)

13667 SUBSTOICHIOMETRIC EXTRACTION AND DETERMINATION OF MERCURY IONS IN THE FORM OF THEIR BROMIDE COMPLEX. Szabadvary, F.; Szarvas, T.; Banyai, E. (Technische Univ., Budapest). J. Radioanal. Chem., 2: 127-31 (Jan. 1969). (In German).

The analytical applications of ^{203}Hg are considered. Labeled mercury nitrate solutions were reacted with bromides and the complex formed was extracted with ether. The activity was measured with a NaI(Tl) scintillation counter and the sensitivity of the method determined. (M.C.G.)

Activation Procedures

Refer also to abstracts 13801, 13974, and 14221.

13668 (BNWL-715(Pt.2)) PACIFIC NORTHWEST LABORATORY ANNUAL REPORT FOR 1967 TO THE USAEC DIVISION OF BIOLOGY AND MEDICINE. VOLUME II. PHYSICAL SCIENCES. PART 2. RADIOLOGICAL SCIENCES. Nielsen, J. M. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Oct. 1968. Contract AT(45-1)-1830. 230p. Dep. CFSTI.

Three sections are included; a separate abstract was prepared for each. (P.C.H.)

For abstracts of individual sections see: 13669, 13740, and 13974.

13669 (BNWL-715(Pt.2), pp 1-149) RADIOLOGICAL CHEMISTRY. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

ATLANTIC OCEAN — beryllium-7 content in
ATMOSPHERE — analysis for particulate tracers, polarographic methods for
ATMOSPHERIC PRECIPITATION — analysis for trace amounts of antimony and cadmium, polarographic methods for
BIKINI ATOLL — radioisotope content in sediments and soils from Bravo Crater on
BIOLOGICAL MATERIALS — analysis of ashed, for americium and plutonium by lithium-activated silicon photon spectrometry
— analysis for lead-210 and total lead, methods for
— separation of americium-241 and plutonium-239 from, by electrodeposition in presence of iron, effects of hydrofluoric acid on
CLAYS — analysis of deep sea, for trace elements by neutron activation and γ spectrometry
COLUMBIA RIVER — analysis for rare earth radioisotopes by group separation and γ spectrometry
ECOSYSTEMS — radioisotope content in Northeast Pacific Ocean, June 1969
ETHYLENE POLYMERS — sorptive properties of container surfaces of, for trace elements in seawater
FIELD LABORATORIES — design and operation of, for use in atmospheric physics and fallout studies
FILTERS — analysis of high-altitude air, for aerosols by neutron activation and γ spectrometry
FISSION PRODUCTS — analysis by radiochemical separation and γ spectrometry
GLASS — sorptive properties of container surfaces of Pyrex, for trace elements in seawater
HYDROFLUORIC ACID — effects on electrodeposition of americium-241 and plutonium-239 from ashed biological materials in presence of iron
IRON — effects on electrodeposition of americium-241 and plutonium-239 from ashed biological materials, effects of hydrofluoric acid on
LIVER — analysis of salmon, for trace elements by neutron activation and γ spectrometry
— analysis for radioisotopes by neutron activation and γ–γ coincidence methods
LUNGS — analysis for trace elements in, from uranium miners by neutron activation and γ spectrometry
MAN — iron-55 content in Eskimos from fallout from 1965 to 1967
— iron-55 content in, in Richland, Washington, 1964 to 1967
— cesium-137 content in, in Richland, Washington, 1964 to 1967
MUSCLES — analysis for trace elements in salmon, by neutron activation and γ spectrometry
— analysis for trace elements by neutron activation and γ spectrometry
— analysis for radioisotopes by neutron activation and γ spectrometry
ORGANISMS — radioisotope content in marine, in Northeast Pacific Ocean, June 1967
OSTEICHTHYES — Oncorhynchus sp., analysis of tissues of, for radioisotope distribution by γ spectrometry
— Oncorhynchus sp., iron-55 content in Pacific Ocean, from fallout from 1965 to 1967
— Oncorhynchus sp., analysis of muscles of, for trace elements by neutron activation and γ spectrometry
— Oncorhynchus sp., analysis of liver of, for trace elements by neutron activation and γ spectrometry
— Oncorhynchus sp., analysis of liver of, for radioisotopes by neutron activation and γ–γ coincidence methods
— analysis of muscle tissues of, for radioisotopes and trace elements by neutron activation and γ spectrometry
— radioisotope content in, in Northeast Pacific Ocean, June 1967
— analysis for trace elements by neutron activation and γ spectrometry
PACIFIC OCEAN — analysis for particulate iron-55, lead-210, and polonium-210 and total iron and lead, methods for
— analysis for trace elements by neutron activation and γ spectrometry
— radioisotope content in ecosystem in Northeast, June 1967
— analysis for trace elements in Northeast, by neutron activation and γ spectrometry
— beryllium-7 content in
RADIATION DETECTORS, SEMICONDUCTOR — performance for use in biological and environmental studies
REACTOR COOLANTS — analysis of water for rare earth radioisotopes by group separation and γ spectrometry
SEAWATER — radioisotope content in ecosystem in Northeast Pacific Ocean, June 1967

—analysis for trace elements in Northeast Pacific Ocean by neutron activation and γ spectrometry
—beryllium-7 content in Atlantic and Pacific Oceans
SILTS—analysis of deep sea, for trace elements by neutron activation and γ spectrometry
—analysis for trace elements in micromanganese nodules in Pacific Ocean
—radioisotope content in, from Bravo Crater at Bikini Atoll
SOILS—radioisotope content in, from Bravo Crater at Bikini Atoll
STRATOSPHERE—analysis for aerosols using air filters by neutron activation and γ spectrometry
SURFACE WATERS—analysis for rare earth radioisotopes by group separation and γ spectrometry
TISSUES—analysis for radioisotope distribution in salmon, by γ spectrometry
—analysis for trace elements by neutron activation and γ spectrometry, self-shielding errors in
WATER—analysis of reactor effluent, for rare earth radioisotopes by group separation and γ spectrometry (P.C.L.)

13670 (CEA-CONF-1162) ACTIVATION ANALYSIS OF CERTAIN TRACE ELEMENTS IN GEOLOGICAL MATERIALS. Schiltz, J. C. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). [1968]. 14p. (In French). (CONF-681205-4). Dep.

From National Conference on Measurement of Elements Occurring in Traces in Rocks, Nancy, France.

Neutron activation techniques were developed for the analysis of geological materials for Co, Cs, Cu, Dy, Eu, Ga, La, Rb, Sc, Sm, Ta, Th, and W. Details of chemical treatment of the samples are given. (J.G.B.)

13671 (CEA-CONF-1183) DESTRUCTIVE AND NONDESTRUCTIVE ANALYSIS OF SOILS AND MINERALS BY NEUTRON ACTIVATION. Aubouin, G.; Dabrowski, H.; Laverlochere, J.; Vial, J. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Nov. 1968. 15p. (In French). (CONF-681205-2). Dep.

From National Conference on Measurement of Elements Occurring in Traces in Rocks, Nancy, France.

The determination of trace elements in soils by neutron activation requires some very effective chemical separations. Studies were made on ion exchange separation after being dissolved by a mixture of HNO_3–HCl–HF–H_2SO_4. The results are given for the elements determined. Studies were also made on minerals, in a nondestructive way, in order to examine the possibilities of applying Ge(Li) detectors for this purpose after neutron irradiation. A large number of elements were determined, including those of low content, this method appearing adaptable to the determination of series, that which constitutes one of the objectives of the study. (tr-auth)

13672 (GAMD-8788) STUDY OF COATING CONTAMINATION IN TRISO FUEL PARTICLES. Steward, K. P. (Gulf General Atomic, Inc., San Diego, Calif.). Sept. 24, 1968. Contract AT(04-3)-633. 21p. Dep. CFSTI.

Very little is known concerning the levels of coating contamination and its distribution in TRISO fuel particles. Experiments were therefore conducted to determine coating contamination profiles through enriched fuel particles using a coating removal and activation analysis technique. While the method is suitable for particles having relatively high contamination fractions in the outer PyC ($\sim 10^{-5}$ fraction or greater), as in BISO particles, it was found that the PyC contamination is so low in good TRISO particles that contamination profiles cannot be determined by this method. Values of $< 1 \times 10^{-6}$ fraction, however, were obtained for the total contamination in the outer PyC of laboratory-prepared TRISO material containing no defective particles. Subsequent determinations of total PyC contamination using an oxidation and xenon counting method showed $< 5 \times 10^{-7}$ fraction in all cases. With such low coating contamination levels, the release of metallic fission products from a batch of TRISO material is governed by the number of defective particles present. (auth)

13673 ANALYSIS OF TRACE ELEMENTS IN AIR-BORNE PARTICULATES, BY NEUTRON ACTIVATION AND GAMMA-RAY SPECTROMETRY. Dingle, A. N. (Univ. of Michigan, Ann Arbor). Atmos. Environ., 3: 85-6(Jan. 1969).

Some criticisms are offered on the paper by Keane and Fisher appearing in Atmospheric Environment, 2: 603-14(1968) (NSA 23: 2248) together with a reply by these authors. (UK)

13674 ISOTOPIC ION EXCHANGE SEPARATION OF RADIOISOTOPES USING AN ACETONE–WATER–HYDROCHLORIC ACID SYSTEM. Peterson, S. F.; Tera, F.; Morrison, G. H. (Cornell Univ., Ithaca, N. Y.). J. Radioanal. Chem., 2: 115-25(Jan. 1969).

Isotopic ion exchange for the rapid separation of radioactive mixtures was further extended through the use of an acetone–water–hydrochloric acid system. Distribution data were obtained for 27 elements in the range of 15 to 90% acetone, 0.3N HCl indicating a number of new separations. The approach was used for the separation of several radioisotopes from short half-life magnesium matrix for activation analysis. The separations were completed in less than 5 minutes. (auth)

13675 DETERMINATION OF BISMUTH IN LEAD BY NEUTRON ACTIVATION ANALYSIS. De Boeck, R.; Adams, F.; Hoste, J. (Ghent Univ.). J. Radioanal. Chem., 2: 109-14(Jan. 1969).

Neutron activation analysis of lead for bismuth was performed through the separation and measurement of ^{210}Po, using two different extraction procedures. The reproducibility of the results was good for lead containing bismuth in higher concentrations. For high purity lead, variations in the bismuth content was found by different analyses of the same sample, owing to inhomogeneity in the distribution of the Bi metal traces. An independent analysis of the same lead samples gave comparable Bi concentrations. (auth)

13676 DETERMINATION OF OXYGEN IN ALUMINUM BY MEANS OF 14-MeV NEUTRONS WITH AN ACCOUNT OF FLUX ATTENUATION IN THE SAMPLE. Brune, D.; Jirlow, K. (Aktiebolaget Atomenergi, Stockholm). J. Radioanal. Chem., 2: 49-54 (Jan. 1969).

A study concerning the determination of oxygen present at low levels in aluminum using the 14-MeV neutron activation technique is presented. Neutron attenuation effects in the aluminum samples comprising scattering and slowing down processes below threshold energy were treated. (auth)

13677 CHARACTERISTIC X-RAYS FROM (n,γ) PRODUCTS AND THEIR UTILIZATION IN ACTIVATION ANALYSIS. Pillay, K. K. S.; Miller, W. W. (Pennsylvania State Univ., University Park). J. Radioanal. Chem., 2: 97-107(Jan. 1969).

The possibility of using characteristic x rays from radioactive elements in activation analysis was investigated with particular emphasis on (n,γ) products. At least 27 of 56 elements investigated were found to yield themselves to activation analysis employing characteristic x rays from electron capture or internal conversion processes during isomeric transition. In presenting the results, a survey made of several elements and the limits of detection of 21 elements were reported. Specific applications of this method were studied for the analysis of copper in a variety of samples (ores, minerals, steels, spent lubricants and human blood). The results of this investigation show that the use of characteristic x rays in activation analysis has several advantages because the energies of these radiations are closely related to the periodicity of the elements themselves. (auth)

13678 RADIOMETRIC MICRO-DETERMINATION OF RARE-EARTH METALS IN THORIUM OXIDE. Youh, C. C. (National Univ., Taipei, Taiwan). Hua Hsueh, No. 1, 27-30(1967). (In Chinese).

An internal-standard method is described for extending the limit of determination of La_2O_3 in ThO_2. A sample of $La(NO_3)_3$ in $Th(NO_3)_4$ solution was irradiated for 1 hr in a thermal neutron flux of $\simeq 3 \times 10^{12}$ neutrons/cm^2/sec. A rare-earth carrier was added to the irradiated solution, and the Th and rare-earth metals in the diluted solution were precipitated by addition of concentrated aqueous NH_3. The Th was separated from the precipitate by dissolving the precipitate in concentrated HCl and adding $Na_2P_2O_7$ to separate Th as ThP_2O_7. The filtrate was treated a second time with NH_3. The precipitate was collected, dissolved in concentrated HCl, and the solution passed through an anion exchange resin. The solution from the resin was diluted and the rare earths precipitated as the oxalates. The precipitate was dried and the 1.9-MeV γ-peak of ^{140}La was counted with a multichannel spectrometer. (TSS)

13679 SENSITIVITY OF PHOTOACTIVATION ANALYSIS USING A BETATRON WITH AN INTERNAL TARGET. Kochevanov, V. A.; Kuznetsov, R. A. Radiokhimiya, 10: 578-84(1968). (In Russian).

Seventy-eight elements were irradiated with the internal beam of a betatron with a maximum bremsstrahlung energy of 24 MeV and the sensitivity of their determination by this method evaluated. Although the maximum sensitivity did not exceed 10^{-5} g, irradiation in a betatron permits rapid analysis of various objects. (tr-auth)

13680 NON-DESTRUCTIVE NEUTRON-ACTIVATION ANALYSIS OF SODIUM IN Mn Zn FERRITE. Yamamoto, Yuroku; Kumamaru, Takahiro; Hayashi, Yasuhisa (Hiroshima Univ.). Radioisotopes (Tokyo), 18: 50-1(Feb. 1969).

A non-destructive neutron activation method has been developed

for determining sodium in Mn Zn ferrites. Samples are irradiated for 15 min at a thermal flux of 5×10^{12} n $cm^{-2} \cdot sec^{-1}$. The net activity in the 1.37-MeV gamma peak of ^{24}Na produced by the (n,γ) reaction in the sample is compared with the activity obtained from a weighed amount of sodium carbonate added in a sodium-free ferrite, irradiated at the same time. Samples containing 0.01 to 0.02% of sodium have been analyzed in good agreement with the results of atomic absorption spectrometry. Under these conditions used, 1 μg of sodium can be determined. (auth)

13681 DETERMINATION OF OXYGEN IN BERYLLIUM BY NEUTRON ACTIVATION METHOD. Karev, V. N.; Dolya, G. P.; Sivokon, N. V.; Tutubalin, A. I.; Khalin, N. F.; Zadvornyi, A. S. (Physical-Technical Inst., Kharkov). Zavod. Lab., 34: 1430-2(1968). (In Russian).

The reaction $^{16}O(n,p)^{16}N$ using 14.7-MeV neutrons was used in the determination of oxygen in beryllium. The intensity of the γ radiation from ^{16}N was measured and compared with standards using a scintillation spectrometer. The sensitivity of the method was 2×10^{-3}% O_2 for a neutron flux of 5×10^8 sec^{-1}. (tr-auth)

13682 APPLICATION OF A BETATRON IN PHOTONUCLEAR ACTIVATION ANALYSIS. Brune, D. (Aktiebolaget Atomenergi, Studsvik, Sweden); Mattsson, S.; Liden, K. Anal. Chim. Acta, 44: 9-14(Jan. 1969).

The determination of fluorine, iodine, lead, and mercury by means of the photonuclear activation technique with a betatron was studied. The detection limits obtained for the elements in the above sequence were 3, 50, 400, and 15 μg, respectively. The technique was applied in the determination of iodine in pharmaceuticals. A rotating sample holder device was inserted in the bremsstrahlung beam of the betatron in order to ensure uniform irradiation of the samples. (auth)

13683 IDENTIFICATION OF METAL–PROTEIN COMPLEXES BY GEL CHROMATOGRAPHY AND NEUTRON ACTIVATION ANALYSIS. Evans, D. J. R.; Fritze, K. (McMaster Univ., Hamilton, Ont.). Anal. Chim. Acta, 44: 1-7(Jan. 1969).

A method for the identification of protein–metal complexes in biological fluids by a combination of gel chromatography and neutron activation analysis is proposed. The distribution of protein–bound copper in human serum is studied as an example of the method. (auth)

13684 ASPECTS OF LOW-TEMPERATURE IRRADIATION IN NEUTRON ACTIVATION ANALYSIS. Brune, D. (Aktiebolaget Atomenergi, Studsvik, Sweden). Anal. Chim. Acta, 44: 15-20(Jan. 1969).

Neutron irradiation of the sample while frozen in a cooling device inserted in a reactor channel is described for the determination of iodine in aqueous samples as well as of mercury in biological tissue and water. For the simultaneous irradiation of a large number of aqueous solutions the samples were arranged in a suitable geometry in order to avoid mutual flux perturbation effects. The influence of the neutron temperature on the activation process is discussed. Potential applications of the low-temperature irradiation technique are outlined. (auth)

13685 VANADIUM CONCENTRATIONS IN COLORADO RIVER BASIN WATERS. Linstedt, K. Daniel (Univ. of Colorado, Boulder); Kruger, Paul. J. Amer. Water Works Ass., 61: 85-8(Feb. 1969).

An investigation was made of the occurrence and behavior of vanadium in the natural waters of the Colorado River Basin. A sensitive neutron activation analysis procedure was developed. The sampling network, analytical procedures, and standard samples are discussed. Vanadium concentrations varied between 0.2 and 49.2 μg/l over the 15-month period studied. (M.C.G.)

13686 DETERMINATION OF TRACES OF Pt, Ir, Ag, AND Cu IN PALLADIUM BY NEUTRON ACTIVATION METHODS. Gil'bert, E. N.; Pronin, V. A.; Ivanov, G. V. Radiokhimiya, 10: 747-8(1968). (In Russian).

Neutron activation determination of Pt, Ir, Au, Ag, and Cu in Pd using ββ′-dichlorodiethyl ether (chlorex), di-n-butyl thiophosphate (DBTPA), dimethylbenzylalkylammonium chloride, and α-n-nonyl pyridine-N-oxide(α-NPO) as extraction agents was developed using prepared radioactive isotopes of the enumerated elements. (R.V.J.)

13687 NEUTRON-ACTIVATION DETERMINATION OF Au, Ag, Pt, Pd, AND Ir IN RHODIUM POWDER. Gil'bert, E. N.; Pronin, V. A.; Sil'vanovich, Yu. A.; Ivanov, G. V. Radiokhimiya, 10: 748-9(1968). (In Russian).

The determination of Au, Pd, Ag, Pt, and Ir in rhodium powder by neutron activation was investigated using extraction separation of gold by β,β′-dichlorodiethyl ether (chlorex) and separation of Pt, Pd, and Ag by di-n-butyl thiophosphate, α-n-nonylpyridine-N-oxide, and dioctyl sulfide. (R.V.J.)

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Refer also to abstracts 13620, 13625, 13626, 13637, 13741, 13744, 13824, 13836, 14337, 14639, 14888, and 15746.

13688 (DP-MS-67-97-X-1) SPECTRAL EVIDENCE OF THE COORDINATION OF LANTHANIDE IONS IN SOLVENT EXTRACTION SYSTEMS. Karraker, D. G. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). May 16, 1968. 3p. (CONF-680912-2). Dep. CFSTI.

From 11th International Conference on Coordination Chemistry, Haifa and Jerusalem, Israel.

The coordination of lanthanide ions in $Ln(NO_3)_3 \cdot 3TBP$ was investigated as a possible cause of deviations of the extraction coefficients of the complexes from a monotonic function of atomic number. (M.C.G.)

13689 (IS-1988) PARTIAL MOLAR HEAT CAPACITIES OF SOME SQUEOUS RARE EARTH CHLORIDES, NITRATES AND PERCHLORATES FROM TENTH MOLAL TO SATURATION AT 25°C. Walters, J. P.; Spedding, F. H. (Ames Lab., Iowa). May 1968. Contract W-7405-eng-82. 96p. Dep. CFSTI.

The specific heat capacities of aqueous $PrCl_3$, $SmCl_3$, $EuCl_3$, $GdCl_3$, $TbCl_3$, $HoCl_3$, $TmCl_3$, $LuCl_3$, $La(NO_3)_3$, $Nd(NO_3)_3$, $Gd(NO_3)_3$, $Er(NO_3)_3$, $Lu(NO_3)_3$, $La(ClO_4)_3$, $Nd(ClO_4)_3$, $Gd(ClO_4)_3$, and $Lu(ClO_4)_3$ were measured from 0.1 molal to saturation at 25°C in an adiabatic single can solution calorimeter. Apparent molar heat capacities, ϕ_{cp}'s, were calculated from the specific heat capacities. Empirical polynomial equations, determined by a least squares method on an IBM 360 computer were used to express ϕ_{cp} versus square root of molality. Partial molar heat capacities of solvent, $\overline{C}_{p1}$, and solute, $\overline{C}_{p2}$, as well as ϕ_{cp} were calculated from the polynomial equations at rounded values of square root of molality. The data showed that in the ϕ_{cp}'s at moderate concentration the rare earth chlorides form two series, one for the heavy rare earths and one for the light with Sm, Eu, and Gd intermediate. The perchlorates show similar behavior. The phenomenon is explained by assuming different first sphere coordination numbers for the light and heavy series. The heavier smaller rare earths can accommodate fewer tightly bound waters in the inner hydration sphere and consequently have more positive ϕ_{cp}'s. The $\overline{C}_{p1}$ data of the concentrated heavy rare earth nitrates and chlorides are evidence for inner hydration sphere complexation of cation by anion. This property shows an upturn as concentration increases which would be observed if such ionic interaction were present. $Lu(NO_3)_3$ is the most extreme example. The $\overline{C}_{p1}$'s in solutions around 6 molal approach that of free water. (auth)

13690 (LA-3995) THE SOLUBILITIES OF SELECTED ELEMENTS IN LIQUID PLUTONIUM. XIII. TITANIUM AND MANGANESE. Bowersox, David F. (Los Alamos Scientific Lab., N. Mex.). Aug. 23, 1968. Contract W-7405-eng-36. 6p. Dep. CFSTI.

The solubility of titanium in liquid plutonium increased with temperature from 1.1 wt % Ti at 700°C to 10.6 wt % Ti at 1000°C. At 700 and 750°C, the data fit the equation: $\log N_{Ti} = 1.90 - 5.03 \times 10^3\ T^{-1}$, where N_{Ti} is the mole fraction of Ti in solution at the absolute temperature T. Above the peritectic temperature of 770°C, the data fit the equation: $\log N_{Ti} = 0.74 - 1.49 \times 10^3\ T^{-1}$. The solubility of manganese in liquid plutonium increases from 9.3 wt % Mn at 850°C to 21.0 wt % Mn at 1000°C. The data fit the equation: $\log N_{Mn} = 1.52 - 2.27 \times 10^3\ T^{-1}$, where N_{Mn} is the mole fraction of Mn in solution. (auth)

13691 (NP-17609) ISOTOPIC EFFECTS IN THE STRUCTURAL PROPERTIES OF MOLECULAR AND IONIC CRYSTALS. Omarov, T. G. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 1964. 83p. (In Russian). Dep. Thesis.

Results of experimental studies of isotopic effects in substance of various lattice parameters and isotopic content are reviewed. Structural studies of solids and in particular the structural studies of nitrogen are also reviewed. Methods and devices used in experimental studies of the isotopic effect by determining the molar volume of the α-modification of nitrogen isotopes are described. The problems related to the temperature dependence of isotopic effects and the relation between the effect of the bond forces in the lattices are correlated using ionic crystals of ^{40}CaO and ^{48}CaO, ^{58}NiO and ^{64}NiO, ^{24}MgO and ^{26}MgO, ^{7}LiH, and ^{7}LiD, ^{6}LiF and ^{7}LiF and the molecular crystals ^{20}Ne and ^{22}Ne, ^{3}He and ^{4}He, H_2, HD, D_2,

and T_2. Conclusions and analysis of the results are included. (96 references) (R.V.J.)

13692 (ORNL-3894) A VERTICAL TUBE FURNACE FOR CONTINUOUSLY CALCINING SOL-GEL-DERIVED ThO_2–UO_2 AT A RATE OF 35 KILOGRAMS PER DAY. Haws, C. C.; Snider, J. W. (Oak Ridge National Lab., Tenn.). Jan. 1969. Contract W-7405-eng-26. 27p. Dep. CFSTI.

A continuously operating furnace for sintering and reducing fragmentary ThO_2–UO_3 (97 mole % ThO_2, 3 mole % UO_3) to ThO_2–UO_2 at 1150°C was developed and tested, using natural oxides. In this furnace, which was vertically mounted and electrically heated, the oxides, as a mixture of chunks and powder, passed downward through an upflowing mixture of argon and hydrogen. A product rate of 35 kg/day was achieved. Auxiliary components to make the furnace applicable to remote operation were designed and fabricated. Conditions that caused bridging of solids in the furnace tube were determined, and procedures were modified to avoid this problem. Also, equipment was developed to break a bridge (in the event that one formed) without damaging the furnace. The quality of the product met all specifications: the minimum mercury density at 500 psi was 9.97 g/cc; the maximum oxygen : uranium atom ratio was 2.01; the minimum packed density (i.e., the minimum percentage of theoretical density after the fragmentary oxides were packed into fuel tubes), was 89.9%; and the volume of gas released on heating to 1200°C was less than 0.01 cc/g. (auth)

13693 (ORNL-4357) CURIUM DATA SHEETS. Rimshaw, S. J.; Ketchen, E. E. (Oak Ridge National Lab., Tenn.). Jan. 1969. Contract W-7405-eng-26. 40p. Dep. CFSTI.

Values are given for composition, specific power, radiation, critical mass, compatibility, thermophysical properties, mechanical properties, chemical properties, biological tolerances, and shielding data for ^{244}Cm metal, curium sesquioxide, curium oxysulfide, curium fluoride, ^{242}Cm, and curium-242 oxide cermet. Data are tabulated. 56 references are given. (P.C.H.)

13694 (UCRL-18657) ZEEMAN EFFECT ON PHOSPHORESCENT LIFETIME OF MATRIX ISOLATED SO_2. Conway, John G.; Meyer, B.; Smith, J. J.; Williamson, L. J. (California Univ., Berkeley. Lawrence Radiation Lab.). Nov. 1968. Contract W-7405-eng-48. 11p. Dep. CFSTI.

The phosphorescent lifetime of SO_2 as a function of magnetic field was studied at 4°K in sulfur hexafluoride, oxygen, and xenon at zero and 26 kGauss and at 20°K in sulfur hexafluoride between zero and 90 kGauss. At high fields, the decay consists of two lifetime components. One is identical with the zero field lifetime of SO_2; the second has a lifetime of approximately 50% longer, depending on magnetic field. (auth)

13695 (UCRL-50552) PREPARATION AND PROPERTIES OF 2-FLUORO-2,2-DINITROETHYL ACRYLATE POLYMERS. Bissell, Eugene R. (California Univ., Livermore. Lawrence Radiation Lab.). Nov. 25, 1968. 9p. Dep. CFSTI.

Various 2-fluoro-2,2-dinitroethyl acrylate polymers and copolymers were prepared and their properties observed in an effort to find a polymer suited for making extrusion-cast explosives and binders for plastic-bonded explosives. Plasticizers significantly lowered the glass transition temperature of the homopolymer, but copolymerization had much less effect. Methods for crosslinking to improve the mechanical properties of the polymers were considered. (auth)

13696 OBJECTIVE COMPUTER-ORIENTED METHOD FOR CALCULATION OF STABILITY CONSTANTS FROM THE FORMATION FUNCTION. Varga, Louis P. (Oklahoma State Univ., Stillwater). Anal. Chem., 41: 323-30(Feb. 1969).

A computer program written in Fortran IV language to calculate the stability constants of simple mononuclear complexes from formation function data was tested using literature data for the Cu(II) ammine, the Ni(II), Cu(II), and Zn(II) fluorides, the uranyl monochloroacetate, and the U(IV) bisulfate systems. The program was applied to the calculation of over-all stability constants using, first, n-ligand concentration data combined from several experimental techniques for measuring the Hf(IV) and Ta(V) fluoride complexes and, second, n-ligand concentration data for the aquo complexes in 1-butanol of Co(II) and Ni(II) obtained by the method of corresponding solutions. New conclusions were reached concerning the nature and stabilities of several of these complex ion systems in both the test series and the final series of calculations. (auth)

13697 UO_2 COMPLEXES WITH PHENOLIC LIGANDS. XI. ON THE REACTION OF URANIUM(VI) WITH MALTOL. Chiacchierini, E.; Havel, J.; Sommer, L. (Univ. of Rome. Purkyne Univ., Brno). Collect. Czech. Chem. Commun., 33: 4215-47 (Dec. 1968).

Complex equilibria in aqueous systems UO_2^{2+}–maltol were investigated spectrophotometrically in relation to pH and metal ion and ligand concentration, and the formation of 1:1-, 1:2- and 1:3-UO_2^{2+} complexes with maltol was proved. In presence of bicarbonate or oxalate ions, various ternary complexes were formed. The solid species, which can be isolated from slightly acidic UO_2^{2+}–maltol solutions, was identified as a 1:2 complex. From the results of the analysis of spectrophotometric measurements the values of equilibrium and stability constants were calculated. (auth)

13698 RAMAN SPECTRUM OF SOLID PHOSPHORUS PENTAFLUORIDE. Levin, Ira W. (National Inst. of Health, Bethesda, Md.). J. Chem. Phys., 50: 1031-2(Jan. 15, 1969).

Studies were made on the effects of liquid structure on ^{15}N chemical shifts, in the course of which the temperature dependence of the ^{15}N chemical shift in liquid $^{15}NH_3$ and $^{15}ND_3$ was determined. For both liquids, the ^{15}N signal of the vapor in equilibrium with the liquid was also determined. The temperature dependence of both liquid $^{15}NH_3$ and $^{15}ND_3$ was essentially linear and parallel for the two systems. The vapor signal was observed at 29°C for both samples and, in each case, was a well-resolved multiplet. It is suspected that a downfield shift of both of these species with decreasing temperature could indicate an increase in the extent of hydrogen bonding in this liquid. (P.C.H.)

13699 COMMENT ON THE FRACTIONATION OF NITROGEN ISOTOPES BETWEEN NO_2^- AND NO_3^- AND BETWEEN NO AND NO_2^-. Spindel, W.; Stern, Marvin J. (Yeshiva Univ., New York). J. Chem. Phys., 50: 569-71(Jan. 1, 1969).

A rebuttal is given to 2 papers published previously and abstracted in NSA 22: 18760 and 18763. (P.C.H.)

13700 REACTION OF URANYL CHLORIDE WITH AMMONIUM HYDROXIDE. Kovba, L. M.; Pechurova, N. I.; Ippolitova, E. A. Vestn. Mosk. Univ., Ser. II. Khim., No. 6, 72-4(Nov.-Dec. 1968). (In Russian).

The composition and structure of products of reaction between uranyl chloride and ammonium hydroxide was investigated. The unit cell dimensions were determined. (auth)

13701 REACTION BETWEEN Ce(IV) AND EDTA IN ACID MEDIUM. Malinina, E. A.; Martynenko, L. I.; Pechurova, N. I. Vestn. Mosk. Univ., Ser. II. Khim., No. 6, 75-8(Nov.-Dec. 1968). (In Russian).

The kinetics of reaction of Ce(IV) with EDTA were studied. The complexing with EDTA was shown to stabilize Ce(IV) at pH 2 in relation to EDTA as a reduction agent. (auth)

13702 GALVANIC PRECIPITATION OF Mo AND W FROM AQUEOUS SOLUTIONS. Kalinovich, D. F.; Kovenskii, I. I.; Smolin, M. D. (Inst. of Problems in Material Studies, Moscow). Ukr. Khim. Zh., 34: 1200-1(1968). (In Russian).

The pure metal content in precipitated layers was analyzed and the optimum conditions for producing galvanized coatings of pure Mo and W were found. Electrolytic precipitation of molybdenum from aqueous solutions of $N_2H_4 \cdot 2\,HCl$ (100 g/l); MoO_3 (40 g/l); NH_4Cl (100 g/l), using a copper cylinder anode, and electrolytic precipitation of tungsten using a bath of H_3BO_3 (100 g/l); Na_2WO_4 (400 g/l); and H_2SO_4 up to pH 5 to 12 is described. The coating process was carried out at 90°C and current density 2.5 A/cm^2. Respective compounds of Mo and W with admixture of the radioactive isotopes ^{99}Mo and ^{185}W were added to the electrolyte bath (with the activity up to 125 to 150 μCi/l). The process was followed by annealing for 2 hr at 1200°C in a highly neutral, purified dry atmosphere. (R.V.J.)

13703 ENTHALPIES OF SOLUTION AND OF FORMATION OF SEVERAL TERBIUM OXIDES. Fitzgibbon, George C.; Holley, Charles E. Jr. (Los Alamos Scientific Lab., N. Mex.). Contract W-7405-eng-36. J. Chem. Eng. Data, 13: 63-5(Jan. 1968). (LA-DC-8123).

The enthalpies of formation of $TbO_{1.510}$, $TbO_{1.709}$, $TbO_{1.817}$, and $TbO_{1.975}$ have been determined to be $\Delta H^0_{f298.15°K} = -223.1 \pm 0.9$, -227.6 ± 0.9, -230.0 ± 0.9, and -232.0 ± 0.7 kcal per mole, respectively. By extrapolation the enthalpies of formation of $TbO_{1.500}$ and $TbO_{2.000}$ were found to be $\Delta H_{f298.15°K} = -222.9 \pm 0.9$ and -232.2 ± 0.7 kcal per mole, respectively. These values were obtained by measuring the enthalpies of solution of terbium metal and terbium carbonate in 1.00M HCl and of terbium carbonate and the various oxides in 6.00M HNO_3 and combining the results with the enthalpy of formation of water. (auth)

13704 EFFECT OF γ-IRRADIATION ON THE ACIDIC PROPERTY OF SOLID NICKEL SULFATE. Tanabe, Kozo; Iizuka, Tokio; Ogasawara, Masaaki (Hokkaido Univ., Sapporo). J. Res. Inst. Catal., Hokkaido Univ., 16: 567-71(Aug. 1968).

The effects of γ irradiation on the acidity, acid strength, and

catalytic activity of solid nickel sulfate has been studied. It was found that the irradiation decreased the acidity at $4.8 \leqq H_0 < 3.3$ of partially dehydrated nickel sulfate heat-treated at 150 to 450°C, but increased that at $3.3 \leqq H_0 < -3$, while it did not change the acidity at acid strength $H_0 \leqq -3$ of the same samples. Hydrated nickel sulfate with no heat-treatment which had no acidity began to show a definite acidity at $3.3 \leqq H_0 < -3$ upon irradiation. Anhydrous form prepared by heat treatment at 550°C did not change its acidic property by irradiation. The catalytic activity of nickel sulfate pretreated at 350°C for the depolymerization of paraldehyde was found to be unchanged by irradiation. From these results, the acidity change and creation of acid sites effected by γ irradiation were considered due to the dehydration of hydrated water of nickel sulfate, as effected also by thermal treatment. (auth)

13705 CATALYTIC PROTIUM–DEUTERIUM EXCHANGE OF PROPANE/HYDROGEN MIXTURES. Jongepier, R.; Sachtler, W. M. H. (Koninklijke/Shell-Laboratorium, Amsterdam). J. Res. Inst. Catal., Hokkaido Univ., 16: 69-95(July 1968).

With a view to its possible use as a test reaction for low-surface-area alloy films, studies were made on the exchange between propane and deuterium. It was found that the product distribution of a deuteration reaction can be described by two parameters: one expressing the kinetic inequivalence of primary and secondary hydrogen atoms in propane, the other characterizing the catalyst selectivity for multiple versus stepwise exchange. A method is presented for calculating the product distribution from this two-parameter model. Calculated distributions were compared with experimental ones obtained on nickel and rhodium at low temperature. Besides, the occurrence of important isotope effects in reactions involving considerable dedeuteration was demonstrated. Severe self-poisoning was found at 50°C with nickel and some copper–nickel alloys. No self-poisoning was detected at −40°C. Under non-suspect conditions, the addition of copper to nickel resulted in a lowering of the catalytic activity. But under self-poisoning conditions some alloys were apparently more active than nickel. (auth)

13706 HYDROGEN–DEUTERIUM EXCHANGE REACTION. Rideal, Eric K. (Imperial Coll. of Science and Tech., London). J. Res. Inst. Catal., Hokkaido Univ., 17: 45-52(July 1968).

Atom reactions involved in the mechanism of H–D exchange are discussed. It was concluded that two HD reactions can take place on a metal catalyst both of the Rideal type, one in which two molecules of gas and the other in which a chemisorbed atom and a molecule are involved. The kinetics of these possible processes should thus conform to Schwab's (Schwab and Killmann, Z. Phys. Chem., N. F., 24: 119(1960)) molecular and Rideal mechanisms, the former preponderating at low pressures. (P.C.H.)

13707 CORRELATION BETWEEN THE CATALYTIC ACTIVITY OF METALLIC FILMS AND CHEMISORBED RADICALS ON THEIR SURFACE. CH_4–D_2 EXCHANGE ON Cu, Ag, Rh, Pt, Re, Ni, Mo, W, AND Ta. Frennet, A.; Lienard, G.; Verhaegen, G. (Laboratoire de Chimie Nucleaire, Brussels). J. Res. Inst. Catal., Hokkaido Univ., 16: 115-53(July 1968). (In French).

In a flow system, the catalytic activity of several evaporated metal films is measured by the isotopic exchange reaction CH_4-D_2 in the 0.1 to 1.0 torr pressure range. On Mo, W, Re, Ni, Ta, and Pt, metals on which the adsorption reactions are slow, catalytic activity variations were observed as a function of time. On Rh the adsorption reactions were fast and the catalytic activity remained constant, under stationary flow conditions, at each temperature, up to 212°C. Neither catalytic activity was measurable on Cu, up to 700°C, nor on Ag, up to 315°C. Methane was not chemisorbed on these metals. It was possible to normalize the rate of exchange on Mo, Rh, W, and Re and thus to determine the reproducibility of results on different films. The flow method showed that CP_3D and CD_4 were species formed under initial conditions, whereas CPD_3 was not. Assumptions are proposed to explain the observed catalytic activity variations. New facts and arguments are presented which have to be considered for the establishment of any CH_4-D_2 mechanism. (auth)

13708 ANALYSIS OF THE PURE ROTATIONAL ABSORPTION SPECTRA OF HYDROGEN SULFIDE AND DEUTERIUM SULFIDE. Miller, R. E. (Michigan State Univ., East Lansing); Leroi, G. E.; Hard, T. M. J. Chem. Phys., 50: 677-84(Jan. 15, 1969).

The far-infrared spectra of H_2S, D_2S, and H_2S-D_2S mixtures at low pressures have been obtained under high resolution. The analysis of H_2S in the pure rotation region showed that the rotational and distortion parameters established from the vibration–rotation measurements by Edwards are appropriate to account for the observed spectrum. For D_2S, comparison of the observed and theoretical spectra suggests that the previously established parameters should be modified slightly. New values for the rotational and distortion parameters for D_2S have been derived from far-infrared and microwave information by the combination–difference method. They are as follows: $A_0 = 5.491_8$, $B_0 = 4.511_3$, $C_0 = 2.444_5$, $\tau_{zzzz} = -0.00213$, $\tau_{xxxx} = -0.00117$, $\tau_{xxzz} = 0.00113$, $\tau_{xzzz} = -0.00036$ cm^{-1}. (auth)

13709 ISOTOPIC EXCHANGE BETWEEN DEUTERIUM AND SOME CYCLIC HYDROCARBONS ON METALLIC CATALYSTS. Roth, Jerome A.; Geller, Baltes; Burwell, Robert L. Jr. (Northwestern Univ., Evanston, Ill.). J. Res. Inst. Catal., Hokkaido Univ., 16: 221-43(July 1968).

Isotopic exchange between deuterium and the following hydrocarbons, cyclopentane, bicyclo[3.3.0]octane, bicyclo[3.2.1]octane, bicyclo[3.3.1]nonane, and cyclopentylcyclopentane has been investigated on supported rhodium, palladium, platinum, and nickel catalysts at about 75°C. The primary processes in isotopic exchange are dissociative adsorptions of deuterium and alkane. The next most important process is the dissociative surface reaction which converts monoadsorbed alkane to diadsorbed alkane. The geometry of diadsorbed alkane is intermediate to an undetermined degree between that of eclipsed alkane and of π-complexed olefin but not very close to the latter. The surfaces of the metals each possesses two or more types of sites with different ratios of the rates of reaction of monoadsorbed alkane to diadsorbed alkane and to gas phase alkane. The ratios seem to vary from metal to metal and to depend upon any strain involved in forming diadsorbed alkane. Palladium is less strain-sensitive than the other metals of the present group. Most of the exchange on rhodium, platinum, and nickel accords with the predictions of the reactions mentioned above. More highly exchanged hydrocarbons also appear in the initial products, particularly on palladium. The formation of these more exchanged products is discussed with reference to their possible formation by roll-over and by π-allyl mechanisms. (auth)

13710 INFRARED AND RAMAN SPECTRA OF SUBSTITUTED HYDRAZINES. I. METHYLHYDRAZINE. Durig, J. R.; Harris, W. C.; Wertz, D. W. (Univ. of South Carolina, Columbia). J. Chem. Phys., 50: 1449-61(Feb. 1, 1969).

The infrared gas phase spectra of methylhydrazine (NH_2NHCH_3), methylhydrazine-d_3 (ND_2NDCH_3), and methylhydrazine-d_6 (ND_2NDCD_3) were measured from 33 to 4000 cm^{-1}. The infrared and Raman spectra of the corresponding compounds in the liquid state were also recorded. A complete vibrational analysis based on band intensity, position, and isotopic shift is presented. A series of sharp Q branches in the far-infrared region facilitated calculations of the torsional barriers. It was assumed that a symmetrical threefold cosine potential governs both rotors in NH_2NHCH_3 and barriers of 3.67 and 3.72 kcal/mole for the methyl and amino torsions, respectively, were calculated. The intensity of the 3182-cm^{-1} line of NH_2NHCH_3 was studied as a function of temperature. The $\Delta H°$ for H-bond formation was found to be −418 cal/mole. Thermodynamic functions for NH_2NHCH_3 were calculated for the temperature range 200 to 3000°K on the basis of a rigid rotator, harmonic oscillator model. (auth)

13711 MASS SPECTROMETRIC DETERMINATION OF HEAT OF SUBLIMATION OF URANIUM. Pattoret, A.; Drowart, J.; Smoes, S. (Univ. Libre, Brussels). Trans. Faraday Soc., 65: 98-112(Jan. 1969).

The vapor pressure of uranium was determined between 1720 and 2340°K: $-\log P_u(\text{atm}) = (26{,}210 \pm 270)/T - (5.920 \pm 0.135)$. The heat of sublimation calculated therefrom is $\Delta H^0_{s,0}(U) = 129.0 \pm 2.0$ kcal/g atom. This result is in agreement with independent measurements of the vapor pressure of uranium, as well as with the values derived from thermochemical cycles based on the dissociation energies of the monoxide and dioxide of uranium and on the vaporization of the monocarbide, the dicarbide, and the monosulphide of uranium. (auth)(UK)

13712 LATTICE CONSTANTS OF ACTINIDE TETRAFLUORIDES INCLUDING BERKELIUM. Keenan, T. K.; Asprey, L. B. (Los Alamos Scientific Lab., N. Mex.). Inorg. Chem., 8: 235-8 (Feb. 1969).

The lattice constants of ThF_4, PaF_4, UF_4, NpF_4, PuF_4, AmF_4, and CmF_4 were redetermined using modern experimental and computational methods. Lattice parameters for the isostructural BkF_4 were obtained in a similar manner. Trends and volume changes in these tetrafluorides and other series of tetravalent actinide fluoride complexes are discussed. (auth)

13713 RAMAN SPECTRA AND VIBRATIONAL ASSIGNMENTS FOR TRIMETHYLAMINE. Clippard, Patty H.; Taylor, Robert C. (Univ. of Michigan, Ann Arbor). J. Chem. Phys., 50: 1472-3(Feb. 1, 1969).

The Raman spectra of trimethylamine in the gas and liquid states as well as the spectra of the deuterated and ^{15}N isotopic species in the liquid state were investigated. (M.C.G.)

13714 EFFECT OF BENDING VIBRATIONS ON THE MAGNITUDE OF HYDROGEN ISOTOPE EFFECTS. Kresge, A. J.; Chiang, Y. (Illinois Inst. of Tech., Chicago). J. Amer. Chem. Soc., 91: 1025-6(Feb. 12, 1969).

Results are reported of an experiment that shows a remarkable isotope effect lowering directly ascribable to transition-state bending vibrations, and from which an approximate value of the frequency of these vibrations may be deduced. The isotope effect on the rate of proton transfer from hydrogen fluoride to ethyl vinyl ether was determined by measuring its ratio in D_2O solution. The isotope effect was found to be 3.35 ± 0.05, which is quite small, less than one-quarter of the value estimated for uncompensated loss of the stretching vibrations of hydrogen fluoride. It was concluded that the value was small because the absence of initial-state bending vibrations leaves the effect of bending motion in the transition state uncompensated. (D.H.M.)

13715 POLARIZATION BEHAVIOR OF NIOBIUM IN NaOH. Piron, D. L.; Nobe, Ken (Univ. of California, Los Angeles). Corrosion, 25: 67-8(Feb. 1969).

The anodic and cathodic behavior of Nb in deaerated 1N NaOH was studied. The steady-state corrosion potential was reproducible and not affected by the addition of chloride ions to the solution. Anodic dissolution, as well as the critical current density and the passive current density, increased with the addition of chloride ions. The primary passivation potential, approximately –1.0 V, was not affected by chloride ions. The steady-state results of galvanostatic polarization indicated that at potentials lower than required for formation of a high resistance anodic film, the passivation behavior of Nb in 1N NaOH is similar to that of Fe and Ni. A reaction sequence to describe the anodic behavior of Nb is suggested. (J.G.B.)

13716 FRACTIONATION OF THE STABLE ISOTOPES OF CARBON AND OXYGEN IN CALCAREOUS MARINE INVERTEBRATES: THE ASTEROIDEA, OPHIUROIDEA, AND CRINOIDEA. Weber, Jon N. (Pennsylvania State Univ., University Park). Geochim. Cosmochim. Acta, 32: 33-70(Jan. 1968).

Five hundred and seventy-three specimens were selected to represent the population of living asteroids. Relatively large and systematic variations in $\delta^{13}C$ and $\delta^{18}O$ occur for different skeletal elements within a single animal. $\delta^{13}C$ and $\delta^{18}O$ values of these different skeletal elements are positively correlated. Asteroid calcite is enriched in ^{12}C and ^{16}O with respect to "inorganic" carbonate and significant differences in isotopic composition exist at the species and higher levels. All of these observations are accounted for by an isotope exchange reaction between respiratory carbon dioxide and dissolved bicarbonate at or near the site of skeletal deposition, a consequence of the primitive respiratory system of the Asteroidea. The distribution of the stable carbon and oxygen isotopes in the skeletal calcite of ophiuroids (brittle stars), an important component of the carbonate-secreting invertebrate fauna over much of the sea floor, was determined for 166 specimens referred to eleven families. Within a single animal systematic differences in $\delta^{13}C$ and $\delta^{18}O$ to the extent of 1 to 2 permil are observed for different skeletal elements, and the $\delta^{13}C$ and $\delta^{18}O$ values are positively but poorly correlated. With the exception of the families Asteronychidae and Gorgonocephalidae, the mean skeletal ^{13}C and ^{18}O contents of the various ophiuroids are similar, but are quite distinct from those of all other analyzed echinoderms (Echinoidea, Asteroidea, Crinoidea) except the irregular or "sand-dollar" echinoids. All of these observations are consistent with the mechanism of carbon and oxygen isotope fractionation in calcification of echinoderms proposed to account for the unusual $^{13}C:^{12}C$ and $^{18}O:^{16}O$ found in echinoid and asteroid calcites. The skeletal calcite of living crinoids is appreciably enriched in ^{12}C and moderately enriched in ^{16}O with respect to calcium carbonate, which might be precipitated inorganically from seawater at the same temperature. Crinoidal calcites are isotopically lighter than those of most other echinoderms, and the stable isotope fractionation model proposed for echinoids, ophiuroids and asteroids applies equally well to crinoids. (auth)

13717 CO-ORDINATION CHEMISTRY OF SCANDIUM. PART I. COMPLEXES OF SCANDIUM(III) CHLORIDE AND THIOCYANATE WITH 2,2'-BIPYRIDYL AND 1,10-PHENANTHROLINE. Crawford, N. P.; Melson, G. A. (Univ. of Strathclyde, Glasgow). J. Chem. Soc., A, No. 3, 427-30(1969).

The reactions of scandium(III) chloride and thiocyanate with 2,2'-bipyridyl (bipy) and 1,10-phenanthroline (phen) were investigated. Conductivity and ir studies suggest that scandium(III) is hexacoordinated in all the complexes, and the products can be formulated as $[ScL_3](CNS)_3$ and $\{ScL_2X_2\} \times$ (L = bipy, phen; X = CNS^-, Cl^-). For the latter species, the chlorides possess cis (C_2) molecular symmetry, while the thiocyanates were obtained with both cis and trans (D_{2h}) symmetries. (auth)(UK)

13718 PROCEEDINGS OF THE 9th INTERNATIONAL CONFERENCE ON COORDINATION CHEMISTRY, ST. MORITZ-BAD, SWITZERLAND, SEPTEMBER 5–9, 1966. Schneider, W. (ed.). Basle, Switzerland, Verlag Helvetica Chimica Acta, 1966. 552p. (CONF-660901-(Abst.)).

Abstracts of papers presented at the conference are included. The papers are arranged under the following headings: organometallic compounds, metal chemistry, transition metal chemistry, equilibria in solution, absorption spectra and ligand field theory, infrared spectra, biologically interesting complexes, miscellaneous, kinetics, sulfur-containing ligands, higher transition metals, Moessbauer and ESR spectra, crystal structures, photochemistry, transition metals bonded to soft ligands, metal complexes with hard ligands, quantum chemistry, Faraday effect, and optical rotatory dispersion. (M.C.G.)

13719 CHEMISTRY OF THE UO_2^{2+} GROUP. II. PREPARATION AND PROPERTIES OF $(C_6H_5)_3PO$ AND $(C_6H_5)_3AsO$ COMPLEXES OF URANYL ACETATE AND THE STRUCTURE OF $(UO_2(CH_3COO)_2(C_6H_5)_3PO)_2$. Panattoni, C.; Graziani, R.; Bandoli, G.; Zarli, B.; Bombieri, G. (Laboratorio di Chimica e Tecnologia dei Radioelementi, Padua). Inorg. Chem., 8: 320-5 (Feb. 1969).

Monomeric complexes of formula $UO_2(CH_3COO)_2L_2$ and dimeric complexes of formula $(UO_2(CH_3COO)_2L)_2$, with L = $(C_6H_5)_3$– PO and $(C_6H_5)_3AsO$, were synthesized from uranyl acetate dihydrate and triphenylphosphine and triphenylarsine oxides, respectively. The reaction products were characterized via elemental analyses, conductivity measurements, and infrared spectral data. The crystal structure of trans-di-μ-acetato-bis(dioxotriphenylphosphine oxide acetate)diuranium(VI), $(UO_2(CH_3COO)_2(C_6H_5)_3PO)_2$, was determined from three-dimensional, single-crystal x-ray film data and refined to a final R value of 0.095. The crystals are triclinic, space group $P\bar{1}$, with one formula unit in a cell with the dimensions a = 8.346 Å, b = 11.022 Å, c = 13.680 Å, $\alpha = 101° 50'$, $\beta = 91° 12'$, $\gamma = 109° 12'$, $D_m = 1.91$ g cm^{-3}, and $D_x = 1.93$ g cm^{-3}. The structure consists of dimeric molecules in which the uranium atoms are seven-coordinated. The coordination polyhedron is a pentagonal bipyramid with an almost linear uranyl group perpendicular to five oxygen atoms at the corners of an irregular pentagonal base. The dimeric units are realized by bridging acetato groups. (auth)

13720 STABILITY OF THE GASEOUS AMMONIUM CHLORIDE MOLECULE. Goldfinger, P.; Verhaegen, G. (Univ. Libre, Brussels). J. Chem. Phys., 50: 1467-71(Feb. 1, 1969).

The equilibrium vapor effusing from a Knudsen cell, in which solid ND_4Cl was evaporated, was analyzed by a quadrupole mass spectrometer. In the temperature range considered (335 to 485°K) the main vaporization process corresponds to the decomposition of the solid toward gaseous ND_3 and DCl; the measured enthalpy change $\Delta H^\circ_{407\ dec}[ND_4Cl(s)] = 42.6 \pm 2.0$ kcal mole^{-1} is very close to that measured for NH_4Cl: $\Delta H^\circ_{407\ dec}[NH_4Cl(s)] = 42.5$ kcal mole^{-1}. Apart from the main gaseous species, small proportions ($5 \times 10^{-5} - 2 \times 10^{-3}$) of ND_4Cl molecules were also observed. The ND_4Cl molecule fragments (>99%) under electron impact and yields the ND_3^+(m/e = 22) ion. From the observed ion intensity ratios, as well as their dependence on temperature, $D^\circ_0(NH_4Cl \rightleftharpoons NH_3 + HCl) = 10.0 \pm 3.0$ kcal mole^{-1} was obtained confirming Clementi's computed prediction <14.0 kcal mole^{-1}. (auth)

13721 DIFFRACTION STUDIES OF THE CRYSTAL STRUCTURES OF URANYL NITRATE DIHYDRATE, MONOAQUOTETRAUREADIOXOURANIUM(IV) NITRATE, AND TETRAETHYL CIS, CIS-3, 8-CYCLODECADIENE-1,1,6,6-TETRACARBOXYLATE. Dalley, Nelson Kent. Austin, Tex., Univ. of Texas, 1968. 114p. Thesis.

The structures of two uranyl ion complexes were obtained using neutron diffraction techniques to determine the uranyl ion coordinations and the hydrogen bonding schemes. X-ray diffraction techniques were used to determine the structure of tetraethyl cis, cis-3, 8-cyclodecadiene-1,1,6,6-tetracarboxylate. This study was undertaken to determine if the conformation of the decadiene ring would allow orbital interaction between the orbitals of the olefinic carbons. This was proposed to account for the stability of the double bonds toward usual olefinic tests. Both uranyl complexes crystallize in the monoclinic space group $P2_1/c$. The lattice parameters of $[UO_2(H_2O)_2(NO_3)_2]$ are a = 14.124 Å, b = 8.432 Å, c = 7.028 Å, $\beta = 108.01°$ with Z = 4. The structure was solved using Fourier techniques with a final weighted R value of 4.9%. The primary coordination of the uranyl ion consisted of six O's, four O's from two equivalent nitrato ligands and two aquo O's from equivalent water ligands. The 6 atoms lie in a plane perpendicular to the linear uranyl ion, the U atoms are located on centers of symmetry. The hydrogen bonding scheme consists of 2 types of bonds, one joining two nonequivalent molecules through a nitrato O and the other, a weaker bond, joining two equivalent molecules through a uranyl O.

These results are consistent with other studies of uranyl complexes but are in conflict both with regards to crystallographic data and bond lengths with a previously reported x-ray study of the same material. The lattice parameters of $[UO_2(H_2O)\{CO(NH_2)_2\}_4](NO_3)_2$ are a = 9.99 Å, b = 14.99 Å, c = 13.18 Å, β = 100.08° with Z = 4. Because of the large number of independent atoms in this neutron study a preliminary x-ray investigation was performed to develop a partial trial structure using the heavy atom technique. The complete structure was obtained using Fourier techniques and refined to a weighted R of 4.8% using the neutron data. The primary coordination of the uranyl ion in this complex is 5-fold consisting of 4 carbonyl oxygens of the urea ligands and one aquo O. The uranyl ion is essentially linear though the U atom is not located on a special position. There are both O–H...O and N–H...O hydrogen bonds present, the two O–H...O bonds of the water ligand terminate on two oxygens, one on each of the nitrate ions. All of the oxygens of the nitrate ions are also involved in one or more N–H...O bonds and these H bonds together with the nitrate ions form a network that connects the four independent molecules. The crystal structure of tetraethyl cis, cis-3, 8-cyclodecadiene-1,1,6,6-tetracarboxylate was solved from x-ray data. The crystallographic data are a = 8.556 Å, b = 10.858 Å, c = 12.723 Å, β = 90.68° and Z = 2. The space group is $P2_1$. Part of the structure was obtained using direct methods for noncentrosymmetric crystals and it was completed using Fourier methods. This structure was confirmed using the partial structure method of Karle. The final weighted R was 9.0%. The results of this study indicated that no orbital interaction was possible as the double bonds were several angstroms apart. (Disser. Abstr.)

13722 CRYSTAL STRUCTURE OF POTASSIUM DITHORIUM TRISPHOSPHATE, $KTh_2(PO_4)_3$. Matkovic, B. (Ruder Boskovic Inst., Zagreb); Prodic, B.; Sljukic, M.; Peterson, S. W. Croat. Chem. Acta, 40: 147-61(1968).

The structure of $KTh_2(PO_4)_3$ was determined from three-dimensional x-ray data. The crystals are monoclinic with a = 17.57, b = 6.863, c = 8.138 Å, β = 101° 46', D_x = 5.45 g·cm^{-3}. The space group is C2/c and there are four formula units per unit cell. It follows from the interatomic distances that the compound is potassium trisphosphatodithorate defined by the formula $K[Th_2(PO_4)_3]$. Nine oxygen atoms are bound to the thorium atom; their distances range from 2.26 to 2.66 Å. Eight oxygen atoms are coordinated around potassium atom; their distances range from 2.74 to 3.09 Å. The distances in the PO_4 groups do not deviate significantly from known data. (auth)

13723 CHEMICAL SHIFTS OF ^{19}F NMR IN DF–D_2O AND DF–H_2O–D_2O SYSTEMS. Borodin, P. M.; Singkh, R.; Shcherbakov, V. A. Zh. Strukt. Khim., 9: 1078-9(Dec. 1968). (In Russian).

The magnitude of the chemical shift (C) of the fluoride NMR δ signal was studied previously in the HF–H_2O system in order to determine the dissociation process and polymerization of HF in the system. An attempt was made to measure the magnitude δ as a function of concentration (C) in a similar deuterated DF–D_2O system. A high-resolving power RYa-2302 spectrometer was used for studying 67% solution of D_2O prepared by absorption of F_2 by D_2O at 0°C. Graphical data developed for the chemical shift as a function of hydrogen fluoride δ(C) in D_2O and D_2O–H_2O and HF–H_2O and HF–D_2O systems (with up to 70% HF) are analyzed. Because of the higher electron recoil in deuterium, the chemical shifts of observed NMR signals of ^{19}F in the DF–D_2O system were anticipated to be higher than the δ in the HF–H_2O system. A uniform variation of δ(C) functions in HF–H_2O and DF–D_2O in the HF–H_2O and DF–D_2O systems up to C ≈ 30% indicated identical dissociation and polymerization of these materials which are similar in structure. (R.V.J.)

13724 DENSITY OF NITRIC ACID SOLUTIONS OF URANIUM AND URANIUM–ALUMINIUM ALLOYS. Moeken, H. H. Ph. (Eurochemic, Mol, Belg.). Anal. Chim. Acta, 44: 225-8(Jan. 1969).

Empirical equations for the density and its temperature dependence as a function of the concentration of the constituents of uranium–acid, basic aluminum, and aluminum–acid solutions were established. (D.H.M.)

13725 THE COPRECIPITATION OF CERIUM(III) AND THORIUM(IV) WITH BARIUM OXALATE. Bykhovskii, D. N.; Petrova, I. K. Radiokhimiya, 10: 520-7(1968). (In Russian).

It was discovered that small quantities of trivalent cerium and tetravalent thorium are capable of penetrating crystals of barium oxalate. In the solid phase formed it is possible to count the anomalous mixed crystals, which have no lower limit of formation. Coprecipitation of cerium and thorium promotes a decrease in the concentration of oxalate ions in solution. The data agree with the premise that complex cations such as $CeC_2O_4^+$ and $ThC_2O_4^{3+}$ compete with barium ions in the process of coprecipitation. (tr-auth)

13726 POLARISATIONS OF THE COPPER(II) AND URANYL ELECTRONIC SPECTRA OF META-ZEUNERITE SINGLE CRYSTALS. Billing, D. E.; Hathaway, B. J.; Nicholls, P. (Univ. of Essex, Colchester, Eng.). J. Chem. Soc., A, No. 2, 316-19 (1969).

The electronic spectra of metazeunerite, $Cu(UO_2)_2(AsO_4)_2.8H_2O$, show clear separation of the copper(II) d–d bands and the bands due to the uranyl ion. The polarizations of the copper(II) bands are consistent with the order of one-electron orbitals, $d_{x^2-y^2} > d_{xy} > d_{z^2} > d_{xz}, d_{yz}$. From the crystal g-values the molecular orbital coefficients were calculated and compared with the values for other copper(II)–oxygen systems of known crystal structure. The extents of in-plane and out-of-plane π-bonding are discussed. The polarizations of the uranyl bands were consistent with their assignment to the components of a $^3\Pi \leftarrow {}^1\Sigma^+$ transition. Interpretation of the presence of z-intensity requires the use of acentric point-groups ($C_{\infty v}$ or C_{4v}). The vibrational interval in the band structure was related to the length of the U–O bonds. (auth) (UK)

13727 STUDIES ON REAGENTS FOR NIOBIUM AND TANTALUM. III. THE REACTIONS OF DIBROMOGALLIC ACID WITH NIOBIUM(V) AND TANTALUM(V). Ackermann, Gerhard; Koch, Siegfried (Institut fuer Anorganische und Analytische Chemie, Freiberg, Ger.). Talanta, 16: 284-8(Feb. 1969). (In German).

The nature and structure of the chelates formed between dibromogallic acid and niobium(V) or tantalum(V) were investigated by spectrophotometric and electrophoretic methods. Depending on the pH and the concentration of the components, the complexes $[NbO_2H_2R]$, $[NbO_2HR]^-$, $[NbO_2R]^{2-}$ and probably $[NbO_2R_3]^{3-}$ and $[TaO_2R_2]^{5-}$ appear to be formed (H_3R = dibromogallic acid). (auth)

13728 CONSTITUTION AND STABILITY OF THE CHELATES FORMED BY QUINQUEVALENT NEPTUNIUM WITH N-2-HYDROXYETHYLIMINODIACETIC ACID. Eberle, S. H.; Wede, U. (Univ., Karlsruhe, Ger. Kernforschungszentrum, Karlsruhe, Ger.). Inorg. Nucl. Chem. Lett., 5: 5-8(Jan. 1969). (In German).

Reaction equations and rate constants were deduced from an analysis of pH-dependent extraction curves. Three chelate forms were found to occur, and the structures of these were derived. (UK)

13729 ANIONIC COMPLEXES OF URANYL FLUORIDES IN NONAQUEOUS SOLUTIONS. Vdovenko, V. M.; Skoblo, A. I.; Suglobov, D. N.; Shcherbakova, L. L.; Shcherbakov, V. A. Radiokhimiya, 10: 527-36(1968). (In Russian).

Compositions and structure of anionic fluoride complexes and mixed complexes containing fluorine, in benzene solutions, were studied by ^{19}F NMR and infrared spectroscopy. In the system $(C_{10}H_{21})_4NF–UO_2F_2$–benzene, two forms of complexes exist: $(C_{10}H_{21})_4N[UO_2F_3]$ and $[(C_{10}H_{21})_4N]_3[UO_2F_5]$. Reactions of these complexes with chloride and nitrate ions were also studied. (tr-auth)

13730 HYDROLYSIS OF NITRATE SOLUTIONS OF Pu(V). Zaitseva, V. P.; Alekseeva, D. P.; Gel'man, A. D. Radiokhimiya, 10: 537-41(1968). (In Russian).

The hydrolytic behavior of Pu(V) in nitrate solutions was studied. It was established that, in the pH region up to 5, the hydrolysis of Pu(V) in nitrate solutions can be ignored. The pH for the start of precipitation of plutonium hydroxide is approximately 6.8 at plutonium concentrations of approximately 2 g/l. The solubility products of plutonium hydroxide were calculated in relation to pH. A second form of hydroxide compound, containing more than one OH^- group, was hypothetically established. (tr-auth)

13731 INDUCED REACTIONS IN RADIOCHEMISTRY. I. INDUCED OXIDATION BY DICHROMATE. Posvol'skii, M. V.; Tsirlin, I. I. Radiokhimiya, 10: 541-5(1968). (In Russian).

The possibility of the induced oxidation of plutonium(IV) by reactions with dichromate was investigated. Rules were formulated for selection of an inductor, which provides complete oxidation (reduction) of the acceptor. (tr-auth)

13732 ISOTOPIC EXCHANGE IN EXTRACTION SYSTEMS THAT CONTAIN MOLYBDENUM CHELATES. Bantysh, A. N.; Dobizha, F. V.; Knyazev, D. A. Radiokhimiya, 10: 557-63(1968). (In Russian).

Kinetics of isotopic exchange were studied in extraction systems that contain hexavalent and pentavalent molybdenum. The limiting stage of the process was found to be the dissociation of the complex. Exchange of ^{99}Mo between Mo(V) and Mo(VI) was accelerated by the addition of trioctylamine. (tr-auth)

13733 COMPLEXING OF Np(VI) WITH FLUORIDE IONS IN $HClO_4$ SOLUTIONS. Krylov, V. N.; Komarov, E. V.; Pushlenkov, M. F. Radiokhimiya, 10: 717-19(1968). (In Russian).

A method of cation exchange was used in studies of complexing

of Np(VI) with fluoride ions in $HClO_4$ solutions (1 and 2 M). The results obtained were correlated with the data for the UO_2^{2+}–HF–H_2O system. It was found that Np(VI) with 2.11 M and 1.04 M $HClO_4$ solutions and (3.4 to 70) × 10^{-3} M HF concentration forms NpO_2F^+. The equilibrium constant of the reaction $NpO_2^{2+} + HF \rightarrow NpO_2F^+ + H^+$ is equal to 130 ± 8 and 157 ± 9 at ion solution force 2.11 and 1.04, respectively. (R.V.J.)

13734 COMPLEXING OF Pu(VI) WITH FLUORIDE IONS IN $HClO_4$ SOLUTIONS. Krylov, V. N.; Komarov, E. V.; Pushlenkov, M. F. Radiokhimiya, 10: 719-22(1968). (In Russian).

An ion exchange method was used for determining the complexing and stability of Pu(VI) with HF in $HClO_4$ solutions. Data obtained showed that Pu(VI) in 2 and 1 M solutions of $HClO_4$ and HF(1.4 to 57.5) × 10^{-3} M concentration formed PuO_2F^+, $PuO_2F_2^0$, $PuO_2F_3^-$, and $PuO_2F_4^{3-}$ complexes. (R.V.J.)

13735 COMPLEXING OF U(VI) WITH FLUORIDE IONS IN $HClO_4$ SOLUTIONS. Krylov, V. N.; Komarov, E. V.; Pushlenkov, M. F. Radiokhimiya, 10: 723-5(1968). (In Russian).

An ion exchange method was used in studying U(VI) complexing with fluoride ions in $HClO_4$ solutions with ionic strength μ = 0.2, 0.5, 1, and 2. Data obtained showed that with U(VI) = 7.12 × 10^7 g-ion and HF = (0.7 to 130) × 10^{-3} M and HCl μ = 2.1, 1.04, and 0.51, uranium(VI) formed a UO_2F^+ complex with formation constants $\beta_1^* = ([UO_2F^+][H^+]/[UO_2^{2+}][HF]) = 20.6 \pm 1.6$; 33 ± 8; 35 ± 8 in solutions with corresponding ionic strength. Complexes of UO_2F^+, $UO_2F_2^0$ and $UO_2F_3^-$ with formation constants β_1^* = 37 ± 6, β^* = 44 ± 8, and β_3^* = 48 ± 10 were formed in solutions with μ = 2.0. (R.V.J.)

13736 SOLUBILITY OF BASIC DICARBOXYLATE SALTS OF Ce(IV), Th(IV), AND U(IV). Merkusheva, S. A.; Skorik, N. A.; Seribrennikov, V. V. Radiokhimiya, 10: 731-3(1968). (In Russian).

Basic dicarboxylate salts of Ce(IV), Th(IV), and U(IV) were prepared and their solubility in perchloric acid or sodium perchlorate solutions was studied at 25 ± 0.05°C and μ = 0.1. Tabulated data showed that the ratio between Ci, Th, U, and acid precipitate in the salts examined was 2:3; and, that the solubility of the salts diminished from glutarate to azelate. Also, it was shown that thorium salts have higher solubility than uranium(IV) salts. (R.V.J.)

13737 THE INFLUENCE OF PROPERTIES, DIMENSIONS, AND SYMMETRY OF MOLECULES ON EQUILIBRIUM OF CHEMICAL REACTIONS. IV. EVALUATION OF THE CHARACTER OF THE SUBSTITUENT AND THE PROPERTIES OF SOLVENTS. Komarov, E. V.; Shpunt, L. B. Radiokhimiya, 10: 729-31(1968). (In Russian).

An attempt was made of calculating equilibrium constants in reactions with tri-n-butyl phosphate (TBP), di-n-butyl n-butylphosphonate, n-butyl di-n-butylphosphinate acid (BDBP), and tri-n-butylphosphine oxide (TBPO) using coordinating centers of nitric acid and uranyl nitrate in reactions of the type $UO_2(NO_3)_2 + 2A \rightleftharpoons UO_2(NO_3)_2A_2$ (where A is phosphororganic reagents). (auth)

13738 THE INFLUENCE OF TRIVALENT URANIUM OXIDATION IN AQUEOUS SOLUTIONS ON THE COMPLETE ELECTROLYTIC REDUCTION OF U(IV). Peretrukhin, V. F. Radiokhimiya, 10: 733-5(1968). (In Russian).

Tabulated data obtained on maximum possible electrolytic reduction of uranium to the trivalent state at room temperature with uranium concentration in solution 50 g/l (0.21 M) and 50 ml catalyst with initial current I_0 = 200 ma showed incomplete reduction due to the thermodynamic instability of uranium lower valence forms. However, an almost complete electrolytic reduction could be achieved in dilute hydrochloric and sulfuric acids in which the rate of trivalent uranium oxidation is very slow. (R.V.J.)

13739 POLIMORFIZM OKISLOV REDKOZEMEL'NYKH ELEMENTOV. (Polymorphism of Rare Earth Oxides). Glushkova, V. B. Leningrad, Izdetel'stvo Nauka Leningradskoe Otdelenie, 1967. 136p.

Results of theoretical and experimental studies on the polymorphism of rare earth oxides are presented. The influence of conditions under which the oxides are obtained on their phase states was studied. The processes of formation of rare earth oxides were examined during thermal decomposition of the oxygen compounds and immediate oxidation of the metals. Considerable attention is given to phase transformations of sesquioxides. The effects of pressure on irreversible and reversible polymorphic transformations of rare earth oxides are also discussed. The influence of water vapor on phase transformations of the oxides, the structure of various modifications of sesquioxides, and the mechanism of polymorphic transformations are discussed. The stability of rare earth oxides in relation to their thermo- and crystallochemistry is treated in detail. Thermochemical constants of various forms of the oxides and a brief survey of the literature on rare earth oxides are included. (tr-auth)

Radiation and Nuclear Chemistry

Refer also to abstracts 13668, 13800, 14027, 14056, 15430, and 15432.

13740 (BNWL–715(Pt.2), pp 151-79) RADIATION CHEMISTRY. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

ALCOHOLS— reactions with hydroxyl radicals in aqueous solutions, rate constants for
AMINO ACIDS— reactions with hydroxyl radicals in aqueous solutions, rate constants for
— effects on γ radiolysis of 3,3′-dioxo[$\Delta^{2,2'}$-biindoline]-5,5′-disulfonic acid in aqueous solutions
BENZOIC ACID, P-AMINO-— radiolysis of aerated, aqueous solutions of, mechanism of electron-pulse and γ
BIOCHEMISTRY— radioinduced reactions in, use of rate constants for reactions of hydroxyl radicals with organic solutes in aqueous solutions for studying
ERIOGLAUCINE— radiolysis of aqueous solutions of, spectral studies on yields from electron-pulse and γ
FREE RADICALS— radioinduced in 7-amino-3-imino-3H-phenothiazine and 3,3′-dioxo[$\Delta^{2,2'}$-biindoline]-5,5′-disulfonic acid in aqueous solutions, ESR spectral studies on
GAMMA RADIATION— effects on aqueous alanine, methanol, serine, and valine solutions, use of nitrobenzene radical ions and nitrous oxide as indicators for reducing species formed from
HETEROCYCLIC COMPOUNDS— reactions with hydroxyl radicals in aqueous solutions, rate constants for
HYDROAROMATIC COMPOUNDS— reactions with hydroxyl radicals in aqueous solutions, rate constants for
HYDROXYL GROUP— reactions with organic solutes in aqueous solutions, rate constants for
— reactions with Erioglaucine in aqueous solutions, rate constants for
[$\Delta^{2,2'}$-BIINDOLINE]-5,5′-DISULFONIC ACID, 3,3′DIOXO-— sodium salt, radiolysis of aqueous solutions of, ESR spectral studies on radicals produced from γ
— sodium salt, radiolysis of aqueous solutions of, effects of amino acids on γ
INORGANIC COMPOUNDS— reactions with hydroxyl radicals in aqueous solutions, rate constants for
ORGANIC COMPOUNDS— reactions with hydroxyl radicals in aqueous solutions, rate constants for
OZONIDES— decay of O_3^- produced by pulse radiolysis, quasi-linearization method for estimation of rate of
PEPTIDES— reactions with hydroxyl radicals in aqueous solutions, rate constants for
3H-PHENOTHIAZINE, 7-AMINO-3-IMINO-— radiolysis of aqueous solutions of, ESR spectral studies on radicals produced from γ
RADIOISOTOPES— accumulation in bottom sediments of McNary Reservoir in Columbia River
— content in bottom sediments in Columbia River, buffering effects of, on levels of waterborne radioisotopes
SUGARS— reactions with hydroxyl radicals in aqueous solutions, rate constants for (P.C.L.)

13741 (COO–1620-3) CHEMICAL EFFECTS OF THE NUCLEAR REACTION $^{14}N(n,p)^{14}C$ IN VARIOUS NITROGENOUS COMPOUNDS. Progress Report, May 1, 1968–April 30, 1969. Vaughan, John D. (Colorado State Univ., Fort Collins. Dept. of Chemistry). Jan. 15, 1969. Contract AT(11-1)-1620. 17p. Dep. CFSTI.

Studies on the hot atom chemistry of ^{14}C and the kinetics of deuteration of aromatic heterocycles are reported. Samples of irradiated potassium azide, KN_3, were dissolved in water prior to analysis for labeled products. Three sets of results were obtained: untreated samples of target dissolved in water; thermally annealed samples of target dissolved in water; and thermally decomposed residues of samples dissolved in water. Data are tabulated. The results are discussed. Kinetics for the deuteration of pyrazole, imidazole, 1,2,4-triazole, and tetrazole are discussed. The relative rates of deuteration of the substrates follow the qualitative order 2-Im ≃ 3(5)-Tri > 5-Tet ≫ 4(5)-Im > 4-Py > 3(5)Py. Theoretical interpretation of these relative rates depends upon proper assignment of appropriate nucleophiles and electrophiles in each case. (P.C.H.)

13742 (NSJ-tr-143) RADIATION INDUCED GRAFT COPOLYMERIZATION OF STYRENE TO POLYETHYLENE SINGLE

CRYSTAL AGGREGATE FILM. Takamatsu, Toshiaki; Konaga, Toshiyoshi; Fukada, Eiichi. Translated from Kobunshi Kagaku, 24: 795-800(Dec. 1967). 12p. Dep.

An abstract of this paper, prepared from the original language, appeared as NSA 22: 21096.

13743 (ORNL-4320) RADIOLYSIS OF TETRAHYDROFURAN-CYCLOHEXENE MIXTURES. PART A. LIQUID PRODUCTS. PART B. GAS YIELDS. Bopp, Charles D.; Myron, J. J. J. (Oak Ridge National Lab., Tenn.). Feb. 1969. Contract W-7405-eng-26. 19p. Dep. CFSTI.

The radiochemical alkylation of tetrahydrofuran was attempted by radiolysis of tetrahydrofuran–cyclohexene mixtures. Instead of the expected saturated codimer, a mixture of unsaturated codimers was formed with a G-value of ~1 at 20°C and 8 at 300°C. The most probable mechanism is by the combination of an α-ether radical with an allylic olefin radical and by the radiochemical isomerization of the primary product. Other products at 20°C were a cyclohexene dimer and a tetrahydrofuran dimer; but at 300°C, only the cyclohexene dimer was formed. Higher boiling products were studied only at 20°C. Studies on gas yields gave evidence that the addition of small amounts of cyclohexene to THF profoundly modified the gaseous yields derived from the radiolysis of the ether. (P.C.H.)

13744 (RD/B/N-1242) THE GAMMA RADIATION-INDUCED EXCHANGE OF ^{18}O BETWEEN CARBON DIOXIDE AND CARBON MONOXIDE. Dominey, D. A.; Mascall, R. A.; Shurlock, B. C. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Dec. 1968. 13p. Dep. CFSTI. UK.

Under irradiation exchange of isotopes occurs between labelled molecules of CO and CO_2. There is a difference between the reported rates of exchange of ^{14}C and ^{18}O. In studies of the exchange of both isotopes under identical conditions preliminary results indicated that the measured rate of exchange of ^{18}O is close to that previously reported for ^{14}C and in disagreement with earlier work on the exchange of ^{18}O. (auth)(UK)

13745 (TID-24935) RADIOLYSIS OF PEPTIDES. Wheeler, Owen H.; Julian, Dolores; Infante, Grabriel (Puerto Rico Nuclear Center, Mayaguez). [1968]. Contract AT(40-1)-1833. 13p. Dep. CFSTI.

Studies were made on the γ radiolysis of glycylglycine using ^{14}C-labeled material. The G_{-M} value (number of molecules reacted/100 eV absorbed) for glycylglycine at an absorbed dose of 10.1 Mrad was 3.40 ± 0.05 for 0.05 M and 0.1 M solutions. A decrease in G_{-M} with increased dose was due to the competition in the radiolysis from the primary products of radiolysis. Studies were also made on the radiolytic species responsible for the formation of the observed products. (P.C.H.)

13746 QUANTUM-CHEMICAL TREATMENT OF THE REACTION OF HOT CARBON ATOMS WITH O_2. Kaufman, Joyce J. (Martin Marietta Corp., Baltimore); Harkins, Jerome J.; Koski, Walter S. J. Chem. Phys., 50: 771-6(Jan. 15, 1969).

Extended Hueckel three-dimensional LCAO–MO calculations were performed for the axial attack of C on O_2 with the objective of determining how the energies of the ground $^1\Sigma^+$ state and several excited states varied as a function of $C-O_{(1)}-O_{(2)}$ distances. The calculated energies for the probable intermediate state (ground $^1\Sigma^+$) indicate that as C moves in from a $C-O_{(1)}$ distance of 4 to 1.5 Å if the $O_{(1)}-O_{(2)}$ distance relaxes to 1.7–1.9 Å, the $C-O_{(1)}-O_{(2)}$ system exhibits an energy minimum indicative of a conditionally stable intermediate. However, when the $C-O_{(1)}$ distance becomes shorter than 1.5 Å the curves indicate clearly that there will be $O_{(1)}-O_{(2)}$ repulsion leading to CO + O. Confirmation of the same mechanism was indicated by the result that when the $C-O_{(1)}$ distance is 1.5 Å or less, the entire system passes from resembling C + O_2 to resembling CO + O. Population analysis results also led to the same conclusion. Thus the LCAO–MO results aid in gaining insight into the mechanism of the reaction as it is proceeding. The method is perfectly general and applicable to the reactions of any other hot atoms and, even more important, is applicable to the whole general problem of reactive collisions. (auth)

13747 CHEMICAL EFFECTS OF ISOMERIC CONVERSION OF ^{133m}Xe IN XENON DIFLUORIDE. Zaitsev, V. M.; Kirin, I. S.; Tikhonov, V. I. Khim. Vys. Energ., 2: 374-5(July-Aug. 1968). (In Russian).

The chemical effects of isomeric conversion of ^{133m}Xe in xenon difluoride in various media were studied using xenon difluoride (50 to 100 mg) irradiated for 72 hr by thermal neutrons at 3×10^{12} neutron/cm^2 × sec. Data obtained on XeF_2 solubility in acetonitrile and nitromethane are tabulated. The curves of γ spectra for the control specimen and xenon specimen collected from XeF_2 solutions in acetonitrile and nitromethane showed less than 2% decomposition for XeF_2 kept in acetonitrile for 96 hr and somewhat lower stability for XeF_2 solutions in nitromethane. However, in both cases it was possible to achieve considerable enrichment by the ^{133}Xe isomer. Special experiments for determining the yield of ^{133}Xe in acetonitrile indicated that almost all the ^{133}Xe was stabilized in elementary form. (R.V.J.)

13748 KINETICS OF Cl_2^- ION ACCUMULATION IN HYDROCHLORIC ACID MATRIX. Ryabova, A. A.; Bugaenko, L. T. (Moscow State Univ.). Khim. Vys. Energ., 2: 380-2(July-Aug. 1968). (In Russian).

The kinetics of dichloride ion accumulation in 6M hydrochloric acid matrix was studied at liquid nitrogen temperature. Curves developed at various doses from 5.8×10^{16} and 3.1×10^{16} eV/ml sec at −196°C show a diminished yield of dichloride ions at high irradiation doses. Thus, though the rate of dichloride ion recombination was slow, a prolonged exposure to radiation may result in destruction of dichloride ions even during the irradiation time. The destruction of ion radicals of Cl_2^- during the course of the experiment due to the recombination reaction explains the nonlinearity of their accumulation. (R.V.J.)

13749 PREPARATION OF CARRIER-FREE ^{64} ^{67}Cu NUCLIDES BY LIQUID–LIQUID EXTRACTION. Bhatki, K. S. (Tata Inst. of Fundamental Research, Bombay); Rane, A. T.; Kabadi, M. B. J. Radioanal. Chem., 2: 73-7(Jan. 1969).

A simple procedure is described for the preparation of carrier-free ^{64}Cu, ^{67}Cu nuclides from a zinc target exposed to fast neutrons. The irradiated target is dissolved in water, and the pH of the solution is adjusted to about six. Radioactive copper nuclides are then extracted with a 1% solution of resacetophenone oxime in cyclohexanone. Zinc is not extracted under these conditions. Radiocopper is back-extracted by shaking the organic phase with dilute mineral acid. About 5 mCi of carrier-free ^{64}Cu can be obtained from 1 g of zinc. (auth)

13750 INVESTIGATION OF FORMS OF STABILIZATION OF ^{51}Cr RECOIL ATOMS IN SOME OXYGEN-CONTAINING COMPOUNDS OF CHROMIUM. Batasheva, V. V.; Kovalenko, Yu. A.; Nesmeyanov, An. N.; Babeshkin, A. M. Vestn. Mosk. Univ., Ser. II. Khim., No. 6, 62-6(Nov.-Dec. 1968). (In Russian).

The ^{51}Cr recoil atoms in Cr_2O_3 were found to stabilize partly in metal form. (auth)

13751 EFFECTS OF ELECTRON IRRADIATION ON THE NONEQUILIBRATE SOLUBILITY OF STRONTIUM AND CALCIUM SULFATE. Gromov, V. V. (Inst. of Physical Chemistry, Moscow). Khim. Vys. Energ., 2: 379-80(July-Aug. 1968). (In Russian).

The effects of electron irradiation on the solubility of fine crystalline precipitates of strontium and calcium sulfates were studied with freshly prepared sulfates irradiated with 750-keV electrons in a nitrogen atmosphere at ~ 60°C. Graphical data are given on the variations of concentration of aqueous solutions of $SrSO_4$ and $CaSO_4 \cdot 2H_2O$ as functions of the absorbed dose. It was observed that during the mixing process the solubility increased to a maximum then slowly diminished to achieve equilibrium. The maximum saturation points of irradiated $SrSO_4$ and $CaSO_4 \cdot 2H_2O$ precipitates are tabulated. (R.V.J.)

13752 FUNDAMENTAL PROCESSES IN RADIATION CHEMISTRY. Ausloos, P. (ed.). New York, John Wiley and Sons, Inc., 1968. 760p. $24.00.

The book is made up of 10 chapters on energy deposition mechanisms, ionic fragmentation processes, decomposition of neutral excited molecules, ion-molecule reactions, inorganic gases, organic gases, organic liquids, radiation induced polymerization, organic compounds in the solid state, and water and aqueous solutions. An abstract was prepared for each of the 10 chapters. (B.L.M.)

For abstracts of individual chapters see: 13753–13762.

13753 ENERGY DEPOSITION MECHANISMS. Klots, C. E. (Oak Ridge National Lab., Tenn.). pp 1-57 of Fundamental Processes in Radiation Chemistry. Ausloos, P. (ed.). New York, John Wiley and Sons, Inc., 1968.

An abbreviated classification of electronic excitation processes, as they may occur in isolated atoms or molecules, is given. A minimum vocabulary is provided for the material in this chapter and for following chapters. The chapter is divided into 4 main sections: excitation mechanisms, excitation cross sections under charged particle impact, experimental investigations of charged-particle excitation cross sections, and aggregate descriptions of energy deposition. One hundred forty references are cited. (B.L.M.)

13754 IONIC FRAGMENTATION PROCESSES. Vestal, Marvin L. (Scientific Research Instruments Corp., Baltimore). pp 59-118 of Fundamental Processes in Radiation Chemistry. Ausloos, P. (ed.). New York, John Wiley and Sons, Inc., 1968.

This chapter is concerned with the fundamental chemistry and physics of the unimolecular reactions of polyatomic ions. The discussion is limited to singly charged positive ions. The experimental and theoretical work that has led to recent advances in the theory of ionic fragmentation is described. A picture of the present understanding of these processes is presented, and lines for future research are suggested. One hundred forty-five references are cited. (B.L.M.)

13755 FRAGMENTATION OF HIGHLY EXCITED NEUTRAL MOLECULES. Sieck, L. Wayne (National Bureau of Standards, Washington, D. C.). pp 119-70 of Fundamental Processes in Radiation Chemistry. Ausloos, P. (ed.). New York, John Wiley and Sons, Inc., 1968.

Fragmentation of relatively complex systems (mainly organic) excited to nonionized levels situated well above the dissociation limit of the ground state, especially where the excitation is monochromatic and the primary processes are reasonably well understood, is emphasized in this chapter. In order to elucidate the parent-daughter relationships at high energies, an effort was made to review these studies that most clearly develop the relationship between a particular mode of fragmentation and the energy content of the parent molecule. Some of the common methods used in an attempt to specifically investigate dissociative channels in highly excited neutral molecules are described, as well as both direct and indirect methods for determining unimolecular decay patterns in excited molecules. Fragmentation patterns are discussed for alkanes; cycloalkanes; unsaturated hydrocarbons; other organic compounds including acetone, pentanone, and methanol; and H_2O, CO_2, N_2O, and NH_3. One hundred twelve references are cited. (B.L.M.)

13756 ION–MOLECULE REACTIONS. Futrell, Jean H. (Univ. of Utah, Salt Lake City); Tiernan, Thomas O. pp 171-280 of Fundamental Processes in Radiation Chemistry. Ausloos, P. (ed.). New York, John Wiley and Sons, Inc., 1968.

The history of ion-molecule reactions is reviewed, and, in light of this history, current understanding of ion-molecule reactions is outlined. A theoretical framework for the kinematics of these reactions and the various experimental approaches now used for investigation of these reactions are discussed in some detail. Some of the systems, which are relatively well understood, i.e., H–H isotopes, rare gases–H, and protonation of methane are discussed at length; and some discussion of systems of more general interest is included. A brief discussion of dissociative charge transfer reactions is tabulated in 9 tables along with rate constants or cross section measurements for these reactions. Three hundred fifty-five references are cited. (B.L.M.)

13757 INORGANIC GASES. Anderson, A. R. (Atomic Energy Research Establishment, Harwell, Eng.). pp 281-345 of Fundamental Processes in Radiation Chemistry. Ausloos, P. (ed.). New York, John Wiley and Sons, Inc., 1968.

The roles of positive ions, negatively charged species, and electronically excited molecules in the radioinduced reactions of inorganic gases are discussed briefly. Gas-phase dosimetry is considered. The following general experimental techniques are discussed briefly: scavenging techniques, isotopic studies, effects of applied electric fields, pulse radiolysis, and luminescence studies. In radiolytic studies of particular gases, special attention is given to work reported since publication of early monographs and texts. For a particular gas, data were selected to describe the major features of the particular reactions and to provide basis for understanding the suggested interpretations. The radiolysis of H_2, hydrogen halides, water vapor, O_2, N_2, NO, NH_3, CO_2, CO, and the radioinduced reaction between H_2 and O_2, N_2 and H_2, and CO_2 and graphite are discussed with reference to mechanism, yields, total dose, effects of pressure, effects of additives, and effects of applied electric fields. One hundred fifty-eight references are cited. (B.L.M.)

13758 ORGANIC GASES. Meisels, G. G. (Univ. of Houston, Tex.). pp 347-411 of Fundamental Processes in Radiation Chemistry. Ausloos, P. (ed.). New York, John Wiley and Sons, Inc., 1968. (ORO–3606-4).

A generalized mechanism was developed for the sequence of events in radiolysis of organic gases from the first step of energy adsorption to formation of the final, stable products. An analysis of information that can be obtained from related fields, i.e., radiation physics, spectroscopy, mass spectroscopy, electron swarms, and photochemistry is presented, as is a short summary of experimental techniques. A description of the radiolysis results obtained from the following pure systems is presented: hydrocarbons, including alkanes, olefins, cycloalkanes, and acetylene; compounds of C, H, and O, including alcohols, ethers, ketones, and esters; compounds containing heteroatoms, specifically halocarbons; compounds of C, H, and N, including amines and azomethanes. A brief discussion of the radiolysis of mixtures concludes the chapter with 313 references being cited. (B.L.M.)

13759 ORGANIC LIQUIDS. Holroyd, Richard A. (Atomics International, Canoga Park, Calif.). pp 413-514 of Fundamental Processes in Radiation Chemistry. Ausloos, P. (ed.). New York, John Wiley and Sons, Inc., 1968.

The fundamental processes in the radiolysis of organic liquids are discussed in the light of current knowledge concerning intermediates, and the principles of the methods used to detect various intermediates, as well as their yields and reactions, are considered. Detailed examination of a linear energy transfer effects in organic liquids and charge and energy transfer processes in mixtures are presented. Four hundred seventeen references are cited. (B.L.M.)

13760 PRINCIPLES OF RADIATION-INDUCED POLYMERIZATION. Williams, Ffrancon (Univ. of Tennessee, Knoxville). pp 515-98 of Fundamental Processes in Radiation Chemistry. Ausloos, P. (ed.). New York, John Wiley and Sons, Inc., 1968.

The historical background of radioinduced polymerization, the formation of intermediates, and recombination kinetics are discussed briefly by way of introduction. The chapter is concerned almost exclusively with addition and ring-opening polymerization, especially the additive polymerization of vinyl, vinylidene, and diene monomers. A lengthy discussion of transient species in radiation-induced polymerization and kinetics and mechanisms of the process is presented. The polymerization of the vapors, ethylene and isobutene, polymerization in solutions of acrylamide in aqueous solutions and styrene in dichloromethane at −78°C; and polymerization of bulk monomers, isobutene, cyclopentadiene, α-methylstyrene, and styrene are detailed. The possibility of anionic polymerization of acrylonitrile at −78°C and nitroethylene is discussed. Copolymerization, polymerization of crystalline monomers, polymerization in the glassy state, and oligomerization are discussed briefly. One hundred ninety references are cited. (B.L.M.)

13761 ORGANIC COMPOUNDS IN THE SOLID STATE. Willard, John E. (Univ. of Wisconsin, Madison). Contract AT(11-1)-32. pp 599-649 of Fundamental Processes in Radiation Chemistry. Ausloos, P. (ed). New York, John Wiley and Sons, Inc., 1968.

This chapter reviews the significance, techniques, results, and potentialities of the study of radiation chemistry of organic solids, excluding polymers. A survey of representative literature is included and 158 references are cited. Experiments that include examples of trapped intermediates and stable products resulting from ionizing radiation, direct photolysis of solutes, reactions of hot H atoms from the photolysis of HI, and the reaction of electrons produced by the photoionization of tetramethyl-p-phenylenediamine are described. (B.L.M.)

13762 WATER AND AQUEOUS SOLUTIONS. Anbar, M. (Weizmann Inst. of Science, Rehovoth, Israel). pp 651-85 of Fundamental Processes in Radiation Chemistry. Ausloos, P. (ed.). New York, John Wiley and Sons, Inc., 1968.

The most recent literature concerning the radiation chemistry of water is surveyed with 199 references being cited. The radiolytic behavior of water is examined from the standpoint of its chemistry, and behavior of the free radicals produced in the radiolysis of water is discussed. Previously reported experimental facts are presented as are plausible interpretations of these findings. Emphasis is put on experimental information accumulated since 1962. (B.L.M.)

13763 LOW TEMPERATURE IRRADIATION OF MONOMER IMPREGNATED CELLULOSIC BODIES. Feibush, A. M. (to United States Atomic Energy Commission). U. S. Patent 3,420,761. Jan. 7, 1969.

A process is described for increasing the tensile strength and hardness of lignocellulosic bodies by impregnating the lignocellulosic body with monomeric vinyl chloride and then radiolytically polymerizing the monomer. The impregnation and irradiation of the lignocellulosic body are carried out at temperatures <−50°C. (AEC)

13764 PROCESS FOR THE PRODUCTION OF TARGETS FOR NEUTRON-PRODUCING ACCELERATORS. Guillame, Marcel; Peters, Jean Marie; Winand, Leon; Govaerts, Jean; Gueben, Georges; Delfiore, Guy; Godar, Serge (to EURATOM). British Patent 1,139,209. Jan. 8, 1969. Priority date June 18, 1965, Belgium.

Targets for neutron-producing accelerators are produced by polymerizing tritium- and/or deuterium-containing monomers by means of one or more catalysts, powdering the resulting polymer, evenly distributing the powdered polymer onto a metal disc coated with an adhesive material to facilitate adhesion of the polymer, and compressing the disc at a pressure of about 4.5 ton/cm^2. The polymer may be mixed with up to 20 wt % of BeO or other material

having thermal, electrical, and nuclear characteristics similar to BeO. (B.L.M.)

13765 METHOD FOR IMPROVING POLYVINYL CHLORIDE FIBER IN HEAT CONTRACTION BY RADIATION-GRAFT-POLYMERIZATION. Sakurada, Ichiro (to Japan Atomic Energy Research Inst.). Japanese Patent 1968-20990. Sept. 9, 1968. Filed Aug. 31, 1964.

Poly(vinyl chloride) fiber can be improved greatly in its heat contraction, thereby extending the application of the fiber. Poly(vinyl chloride) fiber is irradiated under tension in the presence of acrylonitrile while heated at 60 to 80°C; or, after the irradiation, it is heated at 150 to 190°C for 30 min to 1 hr under tension. (NSA of Japan)

13766 UNSTABLE INTERMEDIATES. PART LVIII. AN ELECTRON SPIN RESONANCE STUDY OF γ-IRRADIATED GROUP IIA CHLORIDE HYDRATES. Catton, R. C.; Symons, M. C. R. (Univ. of Leicester, Eng.). J. Chem. Soc., A, No. 3, 446-51(1969).

A variety of radicals was identified by ESR in γ-irradiated hydrates of Group IIA chlorides. These include a Cl_2^- centre in $SrCl_2,6H_2O$, which is notable in having two inequivalent chlorine atoms ($A_{||}$ = 109.1 G for Cl_a and 94.9 G for Cl_b), and a centre thought to be $ClOH^-$ in $BaCl_2,2H_2O$, which is isostructural with the V_K-centres. Trends in the hyperfine parameters for these and related centres are discussed in terms of the electronegativities of their constituent atoms. (UK)

13767 METHOD AND DEVICE FOR PRODUCING ADDITION PRODUCT 1 : 1 AND 2 : 1 FROM ALLYL ACETATE AND CARBON TETRACHLORIDE. Okubo, Masao (to Agency of Industry Science, and Tech.). Japanese Patent 1968-21284. Sept. 12, 1968. Filed Jan. 14, 1966.

A method and apparatus are described for producing 1 : 1 and 2 : 2 addition products of allyl acetate and CCl_4. A highly concentrated solution of allyl acetate in carbon tetrachloride is evaporated by heating, and the azeotropic mixture is liquefied. Then, the liquid is irradiated with γ rays or uv rays while warmed. The product is returned with the unreacted portion to the original flask, where it is protected from its radiation dissociation by the use of a shield. (NSA of Japan)

13768 RADIATION GRAFT-POLYMERIZATION METHOD. Tada, Shotaro (to Sumitomo Electric Industries Ltd.). Japanese Patent 1968-20457. Sept. 2, 1968. Filed Oct. 15, 1964.

A method is proposed for producing various goods, such as an ion-exchange membrane, a cloth-containing rubber sheet, and chemical-resistant gloves by coating the cloth or paper on both sides with a vinyl monomer by immersion in a liquid monomer of the vinyl system and graft-polymerizing the material with the monomer by irradiation. At the same time the rubber material itself is crosslinked. (NSA of Japan)

13769 MOLEKULARE STRUKTUR UND STRAHLENWIRKUNG. Jahrestagung der Deutschen Gesellschaft fuer Biophysik, sowie der Arbeitsgemeinschaft der Deutschen Physikalischen Gesellschaft und der Deutschen Gesellschaft fuer Biophysik, 2 und 3 Juni 1966 in Hannover. (Molecular Structure and Radiation Effects. Annual Meeting of the German Society for Biophysics as well as the Work Group of the German Physical Society and the German Society for Biophysics, June 2 and 3, 1966 in Hanover. Meeting Report.). Glubrecht, H.; Ernst, D.; Hinsch, H.; Knaelmann, M.; Scheuermann, W.; Siebert, W. (eds.). Stuttgart, Georg Thieme Verlag, 1968. 240p. DM 32,-. (CONF-660671).

The 32 papers presented at the Hanover Annual Meeting were compiled, and the discussions following each paper were summarized. Individual abstracts were prepared for 20 of the papers. (J.S.R.)

For abstracts of individual papers see: 13772–13786, 14133, 14134, 14209, 14210, and 14232.

13770 REACTIONS OF HOT PHOSPHORUS ATOMS WITH BENZENE. THE EFFECT OF THE IONIZATION POTENTIAL OF DILUENT. Siuda, A. (Inst. of Nuclear Research, Warsaw). Radiochim. Acta, 10: 142-7(Dec. 1968).

The reactions with benzene of hot phosphorus atoms activated by the (n,γ) process in liquid binary mixtures phosphorus trichloride–benzene and in ternary mixtures phosphorus trichloride–benzene–organic diluent were investigated. Cyclohexane, carbon tetrachloride, nitromethane, trichloroethylene, and isopropyl ether were used as diluents. The distribution of radiophosphorus products was determined by paper chromatography. The main organic product of the reactions between hot phosphorus recoils and benzene was phenylphosphonic acid. The influence of the concentration of benzene and of the nature of the diluent upon the yield of this product was studied. It was found that in the presence of the diluents with an ionization potential higher than that of phosphorus, the yield of phenylphosphonic acid is not proportional to the benzene mole fraction but is higher. The observed effect of the ionization potential of a diluent suggests that the reactivity of the hot phosphorus recoils may be connected with their electric charge and/or perhaps the electronic excitation. (auth)

13771 NANOSECOND PULSE RADIOLYSIS OF POLYSTYRENE AND POLY(METHYL METHACRYLATE). Ho, S. K.; Siegel, Seymore (Aerospace Corp., El Segundo, Calif.). J. Chem. Phys., 50: 1142-52(Feb. 1, 1969).

Polystyrene and poly(methyl methacrylate) (PMMA) containing diphenyl and naphthalene as solutes were studied by nanosecond pulse radiolysis. Solute negative ions were detected in PMMA but not in polystyrene. Solute triplet states were formed in times short compared with the lifetimes of the solute excited singlet states, whose presence was observed via their fluorescence. G(triplet) values of 0.2M samples of naphthalene and diphenyl in polystyrene were estimated to be 1.7 and 1.3, respectively. It is also shown that for high concentrations of solute less than 25% of the solute triplet states is derived from ion neutralization inside the spur. No evidence of intersystem crossing from solute excited singlet states was observed. Triplet yields in PMMA were smaller than those in polystyrene by a factor of 2 or more and were strongly affected by other transient species accumulated in previous irradiations. This latter quenching mechanism appears to involve the precursor, rather than the solute triplet states themselves. Possible modes of solute triplet-state formation are discussed, and it is concluded that triplet energy transfer from the solvent is the most probable mechanism. (auth)

13772 RESEARCH ON CHEMICAL AND BIOLOGICAL RADIATION EFFECTS AS INTERDISCIPLINARY TASKS. Schenck, G. O. pp 3-17 of Molekulare Struktur und Strahlenwirkung. Glubrecht, H. (ed.). Stuttgart, Georg Thieme Verlag, 1968. (In German).

From Annual Meeting of the Molecular Structure and Radiation Effects, Hanover, Ger. See CONF-660671.

By reference to studies in radiation chemistry, it is shown that radiation chemistry is indispensable for study of biological radiation effects. Comparative radiation chemistry leads to a universal chemistry illustrated by photoreactions. Indirect photoreactions proceed through substrate relay mechanisms. These are described. (J.S.R.)

13773 MEASUREMENT OF THE MOBILITY OF RADIOINDUCED IONS IN DIELECTRIC FLUIDS. Schmidt, W. F. pp 18-24 of Molekulare Struktur und Strahlenwirkung. Glubrecht, H. (ed.). Stuttgart, Georg Thieme Verlag, 1968. (In German).

From Annual Meeting of the Molecular Structure and Radiation Effects, Hanover, Ger. See CONF-660671.

A method for measurement of the mobility of radioinduced ions is described. In this method the voltage is permanently applied to the measurement cell. The experimental arrangement is shown. The soft x radiation is almost completely absorbed after passage through 2-mm-thick foils into the liquid. Under the effect of the electrical field the charge carriers produced by the radiation migrate to the corresponding electrodes. If the x radiation is interrupted after a period of time, the ions with the longer path fill almost the entire measurement volume so that the observed ionization current can be traced back to the mobility of these ions. The linear decay of the ionization current after interruption of the x radiation is shown. The results obtained of ion mobility in n-pentane, n-hexane, n-heptane, isooctane, cyclohexane, benzene, decalin, and carbon tetrachloride are tabulated. (J.S.R.)

13774 IONIZATION AND RECOMBINATION IN DIELECTRIC FLUIDS AFTER γ-IRRADIATION. Jacobi, W.; Jahns, A. pp 25-35 of Molekulare Struktur und Strahlenwirkung. Glubrecht, H. (ed.). Stuttgart, Georg Thieme Verlag, 1968. (In German).

From Annual Meeting of the Molecular Structure and Radiation Effects, Hanover, Ger. See CONF-660671.

The effect of primary and secondary recombination on the conductivity induced by γ radiation in dielectric liquids was theoretically and experimentally investigated using n-hexane. Measurements were made with a parallel-plate ionization chamber in which field intensity, electrode distance, and dose output could be varied. The primary recombination can be explained with the help of a theory of recombination of individual ion pairs in compressed gases developed by Onsager. The Jaffe theory of column ionization was not in agreement with results. Without external fields, a G value of 0.13 ± 0.01 was obtained for the ion pairs escaping the primary recombination, independent of ion mobility; a mean escape probability of 3% was derived and a mean original distance of the charge carrier of an ion pair of 80 μ was calculated. The use of liquid-filled ionization chambers in dosimetry is discussed. (tr-auth)

13775 REACTIONS OF O ATOMS AND OH RADICALS IN AQUEOUS SOLUTIONS. Froben, F. W.; Mohrmann, H. pp 40-3 of Molekulare Struktur und Strahlenwirkung. Glubrecht, H. (ed.). Stuttgart, Georg Thieme Verlag, 1968. (In German).

From Annual Meeting of the Molecular Structure and Radiation Effects, Hanover, Ger. See CONF-660671.

The free radicals occurring in the radiolysis of aqueous systems can also be produced by gas discharges. The discharge products were introduced to the ferrous oxide solution. In this manner the effects of ionizing radiation were simulated. The results show that O atoms can oxidize iron(II) sulfate and hexacyanoferrate(II). The atoms occur in high-frequency discharges in water vapor and it is possible that they also play a significant role in the radiation chemistry of aqueous systems. (J.S.R.)

13776 RADIOLYSIS OF DIBENZYLTOLUENE. Melkonian, G. A.; Hattenbach, K.; vom Baur, E. pp 53-9 of Molekulare Struktur und Strahlenwirkung. Glubrecht, H. (ed.). Stuttgart, Georg Thieme Verlag, 1968. (In German).

From Annual Meeting of the Molecular Structure and Radiation Effects, Hanover, Ger. See CONF-660671.

The radiolytic decomposition of dibenzyltoluene under the effect of reactor radiation was investigated. The reaction mechanism for the formation of the radiolytic products is considered. Results suggested that the radiolysis of dibenzyltoluene at 350°C leads, with the participation of filter material, to an equilibrium-like state. Benzene, toluene, etc., were converted consecutively on the one hand into polyalkylbenzenes with several rings and on the other hand the largest molecules were cracked with reformation of the benzene and toluene so that the physicochemical properties of the resulting mixture were stabilized. In contrast radiolysis of the polyphenyls proceeds unilaterally since low-molecular decay products arise only in very low masses because of the lack of aliphatic side chains and compound bridges. (J.S.R.)

13777 PHYSICAL CHANGES IN PHAGE DNA AFTER IRRADIATION IN VIVO AND IN VITRO. Coquerelle, R.; Bohne, L. pp 60-4 of Molekulare Struktur und Strahlenwirkung. Glubrecht, H. (ed.). Stuttgart, Georg Thieme Verlag, 1968. (In German).

From Annual Meeting of the Molecular Structure and Radiation Effects, Hanover, Ger. See CONF-660671.

The detection of radiation damage to DNA in phages irradiated in vivo by physical measurement methods such as viscosity and melting point measurements was investigated on T4 phages. Preliminary in vitro studies showed that irradiation displaces the melting point to lower temperatures with increasing radiation doses. The viscosity decrease of in vivo irradiated phages was apparent at biologically insignificant doses. The melting point profile was not altered even at very high doses. (J.S.R.)

13778 STRUCTURE CHANGES IN IRRADIATED DNA. Cornelsen-Ullrich, M. pp 65-8 of Molekulare Struktur und Strahlenwirkung. Glubrecht, H. (ed.). Stuttgart, Georg Thieme Verlag; 1968. (In German).

From Annual Meeting of the Molecular Structure and Radiation Effects, Hanover, Ger. See CONF-660671.

By use of columns of methylated albumin on kieselguhr, it can be shown that irradiated DNA is bound to the column in an exponential relation to dose. The elution curve shows that the D_{37} is 460 R. By use of this column the dependence of the radiation damage on the chain length was studied. Studies with ultrasonics and uv radiation showed that the principal result of irradiation was crosslinking. (J.S.R.)

13779 INTRAMOLECULAR DIMERIZATION REACTION ON X IRRADIATION OF PURINE NUCLEOTIDES. Keck, K. pp 84-7 of Molekulare Struktur und Strahlenwirkung. Glubrecht, H. (ed.). Stuttgart, Georg Thieme Verlag, 1968. (In German).

From Annual Meeting of the Molecular Structure and Radiation Effects, Hanover, Ger. See CONF-660671.

After irradiation of AMP (adenosine monophosphate) solutions, the solutions were chromatographed on an ion exchange column. Of the six fractions obtained, one was previously unreported. The characteristics of this fraction were determined and compared with the characteristics of AMP. The UV spectrum of the unknown fraction was very similar to that of AMP and only displaced 5 mμ, and the spectrum after deamination was altered the same as that of AMP. It was concluded that the pyridine ring of the unknown fraction was still intact. The glycoside compound of this fraction was split during hydrolysis, and a carbonyl group is formed. (J.S.R.)

13780 EFFECTS OF IONIZING RADIATION ON THE BIOLOGICAL ACTIVITY OF DESOXYRIBONUCLEIC ACID. Hagen, U.; Kroger, H.; Schuchmann, L. pp 88-91 of Molekulare Struktur und Strahlenwirkung. Glubrecht, H. (ed.). Stuttgart, Georg Thieme Verlag, 1968. (In German).

From Annual Meeting of the Molecular Structure and Radiation Effects, Hanover, Ger. See CONF-660671.

Various chemical changes that occur in DNA after irradiation are described. The most significant changes described are the break in the nucleotide chain, alterations of the base, opening of the hydrogen bridge, and polymerization reactions. Which of these modifications impair the biological functions of the DNA the most is considered. (J.S.R.)

13781 CORRELATION BETWEEN INACTIVATION AND BREAKING OF DISULFIDE BRIDGES ON IRRADIATION OF PROTEINS. Dose, K. pp 107-17 of Molekulare Struktur und Strahlenwirkung. Glubrecht, H. (ed.). Stuttgart, Georg Thieme Verlag, 1968. (In German).

From Annual Meeting of the Molecular Structure and Radiation Effects, Hanover, Ger. See CONF-660671.

If crystallized proteins are irradiated with 2-MeV electrons or 70-keV x radiation to a dose of 100 Mrad, their activity is reduced as a rule 10% from that of the controls. Approximately 5 to 10% of all the amino acid residues are destroyed, and initial G values between 4 and 14 are found for the destruction of the individual amino acids. The radiation sensitivity of very different types of amino acids is approximately of the same order of magnitude. Completely in contrast to the radiochemical processes, an extraordinarily selective destruction of the cystine residue was observed in the uv irradiation (λ = 2537 Å) of cystine-containing (disulfide) proteins. Beside cystine only tryptophan was effectively destroyed, and the common amino acids remained practically unaltered. The quantum yields for the destruction of the cystine residue by uv light were strongly dependent on the protein structure and especially on the interactions with neighboring tryptophan residues. Inactivation of this protein depends in the first approximation only on the destruction of the essential cystine residue. Formulas are proposed, which permit a quantitative calculation or estimation of the quantum yields for the cystine destruction and inactivation. (tr-auth)

13782 RADIOINDUCED AGGREGATION AND THE ROLE OF DISULFIDE BRIDGES IN THE INACTIVATION OF RIBONUCLEASE IN AQUEOUS SOLUTIONS. Schuessler, H.; Jung, H. pp 128-33 of Molekulare Struktur und Strahlenwirkung. Glubrecht, H. (ed.). Stuttgart, Georg Thieme Verlag, 1968. (In German).

From Annual Meeting of the Molecular Structure and Radiation Effects, Hanover, Ger. See CONF-660671.

If chromatographically purified ribonuclease A in solution is irradiated under a nitrogen atmosphere, and then separated on Sephadex G-50, two different components are found. One component is enzymatically active ribonuclease, the other consists of aggregated irradiation products, which have only slight enzymatic activity. With increasing dose, cystine, methionine, tyrosine, phenylalanine, lysine, and histidine were destroyed in both components, but glycine was increased slightly. The following conclusions were made: (1) The primary structure of an RNase molecule can be altered without inactivating the enzyme. (2) The inactivated molecules occur principally as aggregates. (3) There are no amino acids whose modification is of special significance for the radiation inactivation of ribonuclease. The study also indicated that the inactivation of RNase by ionizing radiation does not proceed by the modification of cystine. (tr-auth)

13783 RESULTS OF QUANTITATIVE ESR MEASUREMENTS ON γ-IRRADIATED THYMINE, URACIL, AND ADENINE. Pietsch, E. pp 141-6 of Molekulare Struktur and Strahlenwirkung. Glubrecht, H. (ed.). Stuttgart, Georg Thieme Verlag, 1968. (In German).

From Annual Meeting of the Molecular Structure and Radiation Effects, Hanover, Ger. See CONF-660671.

The dose effect curves of γ irradiation of thymine, uracil, and adenine were described by the function $C = C_\infty (1 - \exp(-D/D_0))$, where C is the spin concentration at the dose, D is the saturation value for $D_{-\infty}$, in which the e function assumes the value 1/e. The dose-effect curves of adenine and uracil are composed of two special e curves variable values for D_0 and C_∞. The adenine spectra are broad and the hyperfine structure can not be resolved. The uracil spectra show hyperfine structure, but all lines clearly appearing vary in relation to dose. In thymine none of the dose effect curves can be expressed by a special e curve. The dose effect curve is given. The G values, D_0, and saturation concentration for thymine, uracil, and adenine are tabulated. (J.S.R.)

13784 MECHANISM OF RADIATION DAMAGE TO DNA. Mueller, A. pp 147-50 of Molekulare Struktur und Strahlenwirkung. Glubrecht, H. (ed.). Stuttgart, Georg Thieme Verlag, 1968. (In German).

From Annual Meeting of the Molecular Structure and Radiation Effects, Hanover, Ger. See CONF-660671.

Pure thymine and desoxyribose and mechanical mixtures of these substances were exposed to irradiation at 1 Mrad and the ESR spectra were obtained and compared with each other. Evaluation of the spectrum indicated that the addition of atomic hydrogen to the double bond of the thymine groups is not intramolecular but is an intermolecular process. The hydrogen atom generally arose in a ribose group. The results for thymidine and cystamine at 3 Mrad showed a relative decrease of the HT radical, which occurred from the dilution of thymidine with cystamine. (J.S.R.)

13785 INACTIVATION OF RIBONUCLEASE BY X RADIATION AND ITS DEPENDENCE ON WATER CONTENT AND THE BEHAVIOR OF ITS ESR SPECTRA. Sommermeyer, K.; Schnepel, G. H.; Buss, R. pp 151-5 of Molekulare Struktur und Strahlenwirkung. Glubrecht, H. (ed.). Stuttgart, Georg Thieme Verlag, 1968. (In German).

From Annual Meeting of the Molecular Structure and Radiation Effects, Hanover, Ger. See CONF-660671.

The inactivation rate of ribonuclease is essentially independent of the water content during irradiation and the length of storage in the dry state. Care must be taken when it is stored subsequent to irradiation, such as storage in the dry state before measurement of the activity in a damp state or in solution so that after effects can be completely established. (tr-auth)

13786 ELECTRON SPIN RESONANCE IN IRRADIATED SINGLE CRYSTALS OF NUCLEIC ACID COMPONENTS. Dertinger, H. pp 164-70 of Molekulare Struktur und Strahlenwirkung. Glubrecht, H. (ed.). Stuttgart, Georg Thieme Verlag, 1968. (In German).

From Annual Meeting of the Molecular Structure and Radiation Effects, Hanover, Ger. See CONF-660671.

By the use of dihydrothymine single crystals as an example, it was shown that the $C_5 = C_6$ double bond of the x pyrimidine ring was attacked in irradiation. An analysis was made of the ESR spectrum and the g-tensor. (tr-auth)

13787 THERMAL-ANNEALING BEHAVIOUR OF ^{51}Cr RECOILS IN SOLID CHROMIUM(III) TRIS-ACETYLACETONATE. Gainar, I.; Ponta, A. (Inst. of Atomic Physics, Cluj). Rev. Roum. Phys., 13: 645-7(1968).

The Szilard-Chalmers behavior of solid chromium(III) tris-acetylacetonate was investigated. After thermal- and fast-neutron and γ irradiation, the samples were annealed. An explanation for variations in the thermal-annealing behavior of the three ^{51}Cr species, parent, ionic, and acetylacetonate deficient, is offered. (J.G.B.)

13788 ESR STUDY OF SOME Cr(VI) IRRADIATED COMPOUNDS. Constantinescu, O.; Pascaru, I.; Constantinescu, M. (Inst. of Atomic Physics, Cluj). Rev. Roum. Phys., 13: 607-14 (1968).

The effects radiolysis of $CrO_4(NH_4)_2$ and CrO_4K_2 was studied by ESR. In the γ- and neutron-irradiation of polycrystalline $CrO_4(NH_4)_2$ Cr(V) and Cr(III) were formed. The ESR spectra of CrO_4K_2 irradiated under the same conditions suggested the formation of CrO_3^--type radicals. A mechanism for production by radiolysis of the paramagnetic species formed is proposed. (auth)

13789 RADIATION CHEMISTRY OF LOW-TEMPERATURE AQUEOUS GLASSES. PART 2. SULPHURIC ACID GLASSES CONTAINING CHLORACETIC ACID. Dainton, F. S.; Gopinathan, C. (Univ. of Leeds, Eng.). Trans. Faraday Soc., 65: 143-50(Jan. 1969).

G-values [$G(H_2)$, $G(Cl^-)$, $G(N_2)$, and $G(O_2)$] were recorded for 5.3 M H_2SO_4 glasses containing up to 1.0 M chloracetic acid ±N_2O and γ irradiated at 77°K. From the dependence of $G(H_2)$ and $G(Cl^-)$ on [$ClCH_2COOH$] and the isotopic composition of the hydrogen when $ClCD_2COOH$ was used as the solute it was concluded that $G_{e_m^-}$, i.e., the yield of scavengable electrons is 1.7 but that an additional species which may be mobile energy and can liberate Cl^- from chloracetic acid is formed in a yield of 2.1. The coproduct of Cl^- was found to have an ESR signal appropriate to $\cdot CH_2COOH$. (auth) (UK)

13790 RADIATION CHEMISTRY OF LOW-TEMPERATURE AQUEOUS GLASSES. PART 3. ALKALINE GLASSES EITHER PURE OR CONTAINING ORGANIC CHLORIDE. Dainton, F. S.; Gopinathan, C. (Univ. of Leeds, Eng.). Trans. Faraday Soc., 65: 151-62(Jan. 1969).

On irradiation with γ rays at 77°K alkaline glasses gave small yields of products, $G(H_2) = 0.12 = 2G(O_2)$, and developed ESR and optical spectra ($G\epsilon = 3.7 \pm 0.2 \times 10^4$ for 6N NaOH and $4.2 \pm 0.2 \times 10^4$ for 8N NaOH at $\lambda_{max} = 588$ nm) characteristic of the trapped electron e_t^-. When organic halides RCl were present, the optical and ESR spectra showed that $G(e_t^-)$ was diminished and R· radicals were formed. The kinetics of thermal decay of e_t in these glasses can be interpreted on the bases that the main decay reaction is $e_m^- + O_t^- \rightarrow O_t^{2-}$; and that the trapped electrons are divisible into two or more groups distinguished by temperature-dependent, characteristic half-lives of first-order decay. These and related effects are discussed. (auth) (UK)

13791 RADIATION-INDUCED ADDITION OF HYDROGEN CHLORIDE TO ETHYLENE IN THE GAS PHASE. Johnson, R. A.; Barker, R. (United Kingdom Atomic Energy Authority, Wantage, Eng.). Trans. Faraday Soc., 65: 202-10(Jan. 1969).

The gas phase addition of hydrogen chloride to ethylene, initiated by γ radiation, is a free radical chain reaction yielding ethyl chloride (~99.9% of the total product at $[HCl]/[C_2H_4] \sim 20$). The rate of reaction $\propto I[HCl][C_2H_4]^x$, where I is the absorbed dose rate and x varies from 0 to 0.2 as $[C_2H_4]$ is increased, and the overall activation energy = 11.3 kJ/mole (S.I. units). Ethyl chloride inhibits the reaction by competing for chlorine atoms, and sulfur hexafluoride and carbon dioxide (initially) increase the reaction rate by quenching the incipient vibrationally excited chloroethyl radicals more efficiently than hydrogen chloride. The life-time of the excited chloroethyl radical with respect to dissociation is estimated as 2×10^{-10} sec and this value and the quenching efficiencies of various gases are compared with the results obtained from previous work on the photochlorination of chlorinated olefins. The difference in the values of the overall activation energy between the present work and previous work at much higher pressures can be explained using the excited radical concept. (auth) (UK)

13792 OBTAINING CARRIER-FREE ^{47}Sc. Levin, V. I.; Tronova, I. N.; Savel'ev, G. I.; Shlyagin, K. N.; Timoshevskaya, E. N. Radiokhimiya, 10: 563-8(1968). (In Russian).

The extraction of scandium from aqueous solutions containing HCl and calcium using tributyl phosphate was studied. Tributyl phosphate extraction was used to separate carrier-free ^{47}Sc from neutron-irradiated calcium oxide. The ^{47}Sc obtained did not contain radioactive impurities of more than 0.05%. (tr-auth)

13793 BEHAVIOR OF ATOMS OF RECOIL TRITIUM IN SOLID MIXTURES OF CYCLOHEXANE AND BENZENE WITH ADDITIONS OF IODINE. Avdonina, E. N.; Nesmeyanov, N. Radiokhimiya, 10: 568-74(1968). (In Russian).

The distribution of activity between gaseous, liquid, and high-boiling products from reactions of recoil tritium with solid mixtures of benzene and cyclohexane with additions of iodine was studied. The change in state and additions of iodine had very little effect on reactions of tritium with cyclohexane. Both change of phase and iodine additions sharply increased retention of the tritium in the benzene molecule and decreased yields of HT and polymers. With increasing amounts of the aromatic component in the mixtures, specific activities of both components increased. (tr-auth)

13794 ELECTRON SPIN RESONANCE EVIDENCE ON THE NATURE OF TRAPPED POSITIVE HOLES IN γ-IRRADIATED 3-METHYLPENTANE SYSTEMS AT 77°K. Ichikawa, T.; Ludwig, P. K. (Univ. of Notre Dame, Ind.). J. Amer. Chem. Soc., 91: 1023-4(Feb. 12, 1969).

Results of an ESR study of γ-irradiated 3-methylpentane (3-MP) glasses containing small amounts of tetramethylethylene (TME) which gives direct evidence regarding the nature of the positive hole are presented. The ESR spectrum of 3-MP glass containing 0.3 mole % TME and 0.2 mole % CO_2 after irradiation with a dose of 3.9×10^{18} eV/g min can be attributed to three paramagnetic species. The strong central line deviating slightly toward high field from the free-spin value is attributable to CO_2. Six lines with an average spacing of 22.5 G may be attributed to the 3-MP radical. Superimposed on this group is a set of 13 lines equally spaced at 16.7 G. The presence of 13 lines and the intensity ratios found for the outer lines agree quite well with a paramagnetic species with 12 equivalent protons, with corresponding ratios of 0.083 : 1 : 5.5 ... 5.5 : 1 : 0.083. The result agrees with what may be expected for a species such as a TME radical ion. (D.H.M.)

13795 RADIATIVE EVOLUTION OF GAS FROM POLYMERS IN VACUUM. Martyugov, G. M.; Fefelov, P. A. At. Energ. (USSR), 26: 74-7(Jan. 1969). (In Russian).

Effects of high-energy electron irradiation on the evolution of gases from polymer specimens in a vacuum were studied using 3-MeV accelerator electrons scattered on an aluminum foil. The design of the installation and tabulated data obtained for various polymer materials of various thicknesses are included. Radiation gas evolution ranged from 2.7×10^{-3} to 5.8×10^{-1} molecule/10 eV of absorbed energy. In contrast to previous data the measurements revealed a certain dependence of gas evolution on the magnitude of the dose. (R.V.J.)

13796 DEPENDENCE OF THE G VALUE FOR RADICAL PRODUCTION ON THE PHYSICAL STATE. ten Bosch, J. J.;

Braams, R. (Rijksuniversiteit, Utrecht). Radiat. Res., 36: 544-54(Dec. 1968).

Collagen was modified in several different ways which supplied a number of different samples. Their chemical composition (amino acid composition) was nearly equal; the physical properties (molecular weight and molecular organization) were different. The production of free radicals in these compounds was studied quantitatively with the electron spin resonance method. Differences in radical yield of at most a factor of 5 were observed. The results could be explained by assuming the presence of a radical-turnover process during irradiation, and the occurrence of a fast physical process of energy migration in ordered systems. (auth)

13797 STABILIZATION OF RECOIL ATOMS OF ^{119m}Sn IN TIN OXIDES IRRADIATED IN A REACTOR BY 5.4×10^{21} n/cm^2 DOSES. Babeshkin, A. M.; Bekker, A. A.; Nesmeyanov, An. N.; Fabrichnyi, P. B.; Pokholok, K. V. Radiokhimiya, 10: 752-3 (1968). (In Russian).

Radiation effects of large fluxes of slow neutrons on the stabilization of ^{119m}Sn recoil atom were studied with synthesized tin oxide and dioxide. The Mössbauer absorption spectra showed that the recoil atoms stabilized as tin oxide and metallic tin in the tin oxide matrix were in a less defective environment than in the tin dioxide matrix. Radiochemical analysis of the irradiated tin oxide indicate that 6.7% of recoil atoms of ^{119m}Sn were stabilized in the tin dioxide, 12.8% in metallic tin, and 80.5% in the original compound. (R.V.J.)

13798 STRATIFICATION EFFECTS IN BINARY LIQUID SOLUTIONS INDUCED BY RADIATION. Lytkin, L. K.; Pisarev, A. F.; Sumbaev, A. P.; Chalkin, S. F. (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksp. Teor. Fiz., 56: 73-7(Jan. 1969). (In Russian).

The effects of gamma irradiation on the rate of stratification of binary liquid solutions in the supersaturated state was studied experimentally. Irradiation accelerates the decomposition of such solutions as nitrobenzene in hexane or water in triethylamine. Supersaturation was attained by rapid decrease of the pressure above the solution surface or by pulsed application of a field. (auth)

Radiochemistry

Refer also to abstract 15452.

13799 (COO-890-10) PREPARATION OF ^{14}C AND TRITIUM LABELED COMPOUNDS BY HYDROBORATION AND TRITIOBORATION PROCEDURES. Technical Progress Report, May 1, 1968-April 30, 1969. (Illinois Univ., Urbana. Radioisotope Lab.). Contract AT(11-1)-890. 8p. Dep. CFSTI.

The controlled thermal breakdown of carbon-14- and tritium-labeled 1-hexenes has been studied by using the pyrolytic radiogas chromatography technique and found to be isotopically reliable. Now this method can be used to determine the position or positions of carbon-14 or tritium labeling in milligram quantities of an olefinic compound with analysis times of less than one hour as compared to the weeks required for similar determinations by chemical degradation. In addition, important information regarding the mechanism of pyrolysis of 1-olefins has been obtained. Finally, the breakdown of radioactive n-hexane and non-radioactive alkylbenzenes has been studied. The problems encountered in generating and reacting diborane with olefins on a five millimole scale or less have been solved. High vacuum line techniques have been developed to carry out these reactions in nearly quantitative yield. Work is continuing on the synthesis of high-level tritium-labeled compounds by using suitable chemical reactors in tandem with a preparative gas chromatography apparatus. (auth)

13800 (COO-1617-13) HALOGEN ATOM REACTIONS ACTIVATED BY RADIATIVE NEUTRON CAPTURE AND ^{82m}Br AND ^{130m}I ISOMERIC TRANSITION. Progress Report No. 3, February 1968-February 1969. (Nebraska Univ., Lincoln. Dept. of Chemistry). Feb. 15, 1969. Contract AT(11-1)-1617. 124p. Dep. CFSTI.

Research progress is reported on the following: iodine organic yields in hydrocarbon matrices, radiative neutron capture organic yields as an indication of the state of aggregation of ICl and I_2 in C_6 hydrocarbons at 77°K, radiative neutron capture and isomeric transition-activated reaction of bromine in solid benzene at 77°K, radiative neutron capture and isomeric transition-activated iodine reactions in liquid alkylbenzene compounds, reactions induced by (n,γ) activation of ^{128}I in homologous halomethane gases, and influence of rare gase and molecular additives on ^{130}I reactions activated by radiative neutron capture and isomeric transition processes with methane. (M.C.G.)

13801 (DP-MS-68-60) CATALOGUE OF GAMMA RAYS EMITTED BY RADIONUCLIDES. Wakat, M. A. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). July 23, 1968. Contract AT(07-2)-1. 8p. (CONF-681003-10). Dep. CFSTI.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md.

A catalog is being prepared that will include all measured gamma rays emitted by radioactive nuclei and the new energy information provided by Ge(Li) spectroscopy. The format of this tabulation is illustrated. The energies of the gamma rays are listed to 0.1 keV if reported to this level of precision. The mechanics of tabulation using the IBM 360 computer are discussed. (M.C.G.)

13802 SPONTANEOUS ACTIVITY OF LEAD. Kolb, Walter A. (Physikalisch-Technische Bundesanstalt, Brunswick). pp 1385-91 of Radiation Protection. Part 2. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968. (In German).

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.2)).

Because of the increasing significance of shielding material of low characteristic activity, some studies were made on lead. The solution to two questions was sought: (1) the origin of the ^{210}Pb content of commercial lead and (2) the possibility of preparing lead of low characteristic activity. The following series of measurements were made: (1) measurement of the β pulse rate of compressed ore concentrate samples from various countries and investigation of the metal melts prepared, (2) continuous measurement on raw lead samples from the blast furnace over a period of several weeks, (3) measurement of lead samples from the individual refining stages, and (4) investigation on the effect of lead scrap and flux materials. The results show that it is possible through selection of suitable types of ores to prepare lead of very low characteristic activity. In commercial lead a part of the activity originates from lead scraps smelted together and a part from flux materials. Therefore, the smelting methods play a decisive role. The most favorable results were found in Swedish electric oven lead although the smelted ores did not have a specially low characteristic activity. The β pulse rate usually measured on lead samples was compared with the practically important γ pulse rate of a lead shield. (tr-auth)

13803 DETERMINATION OF THE INTENSITY OF CHARACTERISTIC X RADIATION EXCITED BY RADIOACTIVE SOURCES EMITTING β RADIATION. Voljin, Valentina (Univ., Bucharest); Bek-Uzarov, Dj.; Paligoric, D. Rev. Roum. Phys., 13: 621-35 (1968). (In Rumanian).

By determining the intensity of characteristic x radiation excited by β sources, the contribution of the principal phenomena that result in the production of the radiation was calculated. Bremsstrahlung radiation was calculated from the Bethe-Heitler relation and the contribution of direct β-x excitation from the Markhov model. A 4π gas flow proportional counter was used for experimental verification of calculations. It is concluded that use of a more accurate model for representing the penetration of electrons in the target would permit a better comparison between theoretical and experimental results. (tr-auth)

Separation Processes

Refer also to abstracts 13635, 13674, 14296, and 14311.

13804 (ANL-Trans-704) NONAQUEOUS FUEL PROCESSING: RESEARCH CONDUCTED IN FRANCE. Bourgeois, M.; Faugeras, P. Translated for Argonne National Lab., Ill., from Symposium on Nonaqueous Reprocessing, Mol, Belgium, 28-29 October 1968. 5p. (CONF-681040-1). Dep. CFSTI.

A research program dealing with nonaqueous irradiated fuel reprocessing is described first for alloys based on enriched uranium and then for breeder reactor fuels. Finally, a technical and economic comparison between the aqueous and nonaqueous processes is made. (auth)

13805 (ANL-Trans-705) TREATMENT OF ALLOYS BASED ON ENRICHED URANIUM: FIRST RESULTS OF THE OPERATION OF THE "ATTILA" FACILITY. Rochedereux, Y.; Perrot, M.; Mantega, M.; Manevy, G.; Bourgeois, M. Translated for Argonne National Lab., Ill., from Symposium on Nonaqueous Reprocessing, Mol, Belgium, 28-29 October 1968. 31p. (CONF-681040-6). Dep. CFSTI.

The facility and the chemical scheme of the process used for treatment of U-Zr and U-Al alloys are described and the tests performed with unirradiated alloys are outlined. Results ob-

tained with irradiated fuels are presented. Technological problems related with the operation of the facility are noted. The ATTILA facility is intended for testing of a nonaqueous reprocessing method using the volatilization of fluorides with alloys based on highly enriched uranium. (auth)

13806 (ANL-Trans-706) DIRECT CONVERSION OF UF_6 INTO UO_2. Hiemeleers, J.; Himeleers, H. Translated for Argonne National Lab., Ill., from Symposium on Nonaqueous Reprocessing, Mol, Belgium, 28–29 October 1968. 9p. (CONF-681040-3). Dep. CFSTI.

A nonaqueous method developed for the direct conversion of UF_6 into UO_2 consists of two steps: production of uranyl fluoride by the reaction of UF_6 with steam, followed by the conversion of this uranyl fluoride into UO_2 by reduction with a hydrogen–steam mixture. Factors influencing the value of the specific surface of the products, such as temperature, bed granulometry, UF_6 feed rate, steam flow rate, excess of H_2O in hydrolysis, and the linear gas velocity are discussed. Characteristics of the UO_2 powders obtained are described. (P.C.H.)

13807 (ANL-Trans-707) DECLADDING OF UO_2–PuO_2 STAINLESS STEEL FAST REACTOR FUELS BY LIQUID METALS. Payrissat, M.; Wurm, J. G. Translated for Argonne National Lab., Ill., from Symposium on Nonaqueous Reprocessing, Mol, Belgium, 28–29 October 1968. 14p. (CONF-681040-5). Dep. CFSTI.

A process for fuel element decladding by liquid metals is described. It is essentially applied to stainless steel-clad UO_2–PuO_2 fuels for fast reactors. This method permits dissolution of the cladding, separation of the fuel, its concentration for chemical reprocessing, and its refabrication on the reactor site. The study showed that an alloy based on antimony is particularly suited for dissolution of stainless steel at a temperature below 1000°C. The experiments showed the dissolution performance (rate, temperature, degree of dissolution) with several types of steels and nickel-based alloys, which are applicable as cladding materials. Dissolution curves support the results. The homogeneity of the structure of the solvent after dissolution is demonstrated by some micrographic studies and is interpreted by a study with an electron microprobe. (auth)

13808 (ANL-Trans-708) METHOD FOR A LONG-TERM ECONOMIC COMPARISON OF NONAQUEOUS AND AQUEOUS REPROCESSING AS A PART OF THE FUEL CYCLE OF BREEDER REACTORS. Thiriet, L. Translated for Argonne National Lab., Ill., from Symposium on Nonaqueous Reprocessing, Mol, Belgium, 28–29 October 1968. 27p. (CONF-681040-7). Dep. CFSTI.

A method is presented for a long-term comparison of different reprocessing methods as a part of the fuel cycle of breeder reactors. The respective advantages and disadvantages of the nonaqueous and the aqueous method are considered. The recommended method consists of studying the optimum sizes and locations of fuel reprocessing plants for breeder reactors within the scope of an increasing demand for nuclear power. A compromise between the economies of scale resulting from a growth of plants and the economic losses due to an increase in transportation costs and a poor utilization factor of the plants is suggested. (auth)

13809 (ARH-SA-20) AQUEOUS CITRATE FOR PLUTONIUM–URANIUM PROCESSING. Knights, R. L. (Atlantic Richfield Hanford Co., Richland, Wash. Separations Chemistry Lab.). Nov. 1968. Contract AT(45-1)-2130. 9p. Dep. CFSTI.

Aqueous citrate was investigated as an agent for stripping uranium from a TBP stream in fuel reprocessing. Citrate solutions also provide a means of plutonium–uranium partitioning. In the optimum pH range (3 to 5), the uranium will strip completely (>95%) into aqueous citrate. (M.C.G.)

13810 (BNWL-829) REMOVAL OF ^{137}Cs FROM ALKALINE CONDENSATE WASTES. Mercer, B. W.; Ames, L. L.; Parkhurst, R. G. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Nov. 1968. Contract AT(45-1)-1830. 36p. Dep. CFSTI.

Cesium-137 was effectively removed from ITS, SX, and 242-T condensates by ion exchange on AW 500 columns. The AW 500 columns were capable of processing 5000 or more column-volumes to breakthrough of the ^{137}Cs. Suspended matter in the ITS and 242-T condensate required filtration of these wastes to allow efficient utilization of the AW 500 ion exchange capacity. Filtration with 5μ Cuno filters reduced the turbidity sufficiently to prevent rapid plugging of the columns. A 7M $NaNO_3$ solution was effective for regenerating the AW 500 columns. Regeneration was accomplished in 10 to 20 column-volumes at 65 to 70°C. Regression equations are given for computing the percent ^{137}Cs eluted as a function of $NaNO_3$ concentration, temperature, and flow rate within the ranges studied. Temperature and $NaNO_3$ concentration were found to be the most important parameters with respect to elution efficiency. Although ^{137}Cs may be reduced to drinking water limits ($\frac{1}{10}$ MPC_w 168 hr) it does not appear likely that all of the radionuclides in ITS condensate can be economically reduced to this level. While the other fission products such as ^{106}Ru can be removed with strong base and strong acid ion exchange resins, no practical method exists for removing the tritium. A DF of about 10 is required to meet the drinking water limit in ITS condensate for both ^{106}Ru and ^{3}H. (auth)

13811 (BNWL-856) CATALYTIC OXIDATION OF RADIOACTIVELY CONTAMINATED ORGANIC WASTES. Knoll, K. C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan. 1969. Contract AT(45-1)-1830. 13p. Dep. CFSTI.

A method for oxidizing liquid organic wastes from a nuclear fuel separations plant using a catalytic bed as a method of disposal was investigated. Wastes were fed either as a liquid or vapor, together with a flow of air, through the catalyst bed. Oxidation took place with the generation of heat. Off-gases were contained and could be monitored. A list of some catalysts used as well as the organics oxidized by this method is presented. (auth)

13812 (BNWL-860) REACTIONS OF ORGANIC WASTES AND SOILS. Knoll, K. C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan. 1969. Contract AT(45-1)-1830. 15p. Dep. CFSTI.

The passage of certain organic wastes from a radionuclide separations plant has little effect on the permeability of the soil for later passage of a high salt aqueous waste, or on the ion exchange properties of the soil. Soil removed ^{239}Pu and ^{241}Am slowly from some of the organics and not at all from others. Radionuclides were leached from soils most noticeably by two of the wastes. One was a mixture of 0.4M bis(2-ethylhexyl)ester of phosphoric acid and 0.2M tributyl phosphate in paraffin hydrocarbons (C_{10} to C_{14}); the other was hydroxyacetic acid. Both of these removed ^{85}Sr and ^{241}Am and to a lesser extent ^{239}Pu. (auth)

13813 (BNWL-SA-1493) INVESTIGATION OF NTA AS A REPLACEMENT FOR DTPA IN THE ION-EXCHANGE PURIFICATION OF PROMETHIUM. Wheelwright, E. J.; Myers, T. R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar. 8, 1968. Contract AT(45-1)-1830. 19p. (CONF-680308-15). Dep. CFSTI.

From 155th National Meeting of the American Chemical Society, San Francisco, Calif.

Recent laboratory experiments have shown that when nitrilotriacetic acid (NTA) is substituted for diethylenetriaminepentaacetic acid (DTPA) in the promethium purification flowsheet, the ion-exchange elution position of yttrium is moved to a place ahead of gadolinium; yielding an elution order: Y^{+3}, Gd^{+3}, Eu^{+3}, Sm^{+3}, Pm^{+3}, Nd^{+3}, Pr^{+3}. This shift removes yttrium from the critical Sm–Pm–Nd zone of the rare earth series. In a sequence of standardized experimental separations, NTA was found to give markedly superior separation in the Sm–Nd portion of the rare earth series (exactly where needed for promethium separations) than in the Nd–Pr zone. In addition, the kinetics were found to be much faster in the NTA system. Specifically, a 100% increase in the rate of band advance can be achieved while maintaining a separation efficiency at least equal to that obtained for the current DTPA process. The resulting 50% decrease in process cycle time represents a significant technological improvement. An economic advantage is also gained by the switch from DTPA to NTA. The shorter time cycle results in less resin radiolysis per run; thus increasing the number of production runs that can be made before the resin must be discarded. NTA costs only half as much per pound as DTPA. The use of NTA, therefore, reduces chemical costs for the complexing agent by 50% since their concentration in the eluting solution is the same on a weight basis. (auth)

13814 (CEA-CONF-1129) ANALOG SIMULATION OF MIXER–SETTLERS. Response of a Uranium Extraction Column with 30 Percent TBP to a Concentration Step Limited in Acid and Uranium. Kikindai, T.; Michel, P.; Rouyer, H.; Chazal, G. ([Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires]). [1967]. 19p. (In French). (CONF-680941-4). Dep.

From International Symposium on Analogue and Hybrid Computation Applied to Nuclear Energy, Versailles, France.

Mathematical equations and models were developed for calculation of concentrations in various stages of a system used for solvent extraction of uranium in nitric acid solution using tributyl phosphate. Calculations are possible under a variety of conditions of fluid flow, nitric acid or uranium concentrations, etc. (J.G.B.)

13815 (CEA-CONF-1178) RECENT FRENCH EXPERIENCE IN REPROCESSING. Sousselier, Y.; Jouannaud, C.; Delange, M.; Couture, J. [1968]. 17p. (CONF-681101-11). Dep.

From International Conference on the Constructive Uses of Atomic Energy, Washington, D. C.

The development of fuel reprocessing in France is reviewed. The experience gained in the field of new installations or process modifications is discussed. (M.C.G.)

13816 (CEA-CONF-1193) TREATMENT OF ENRICHED URANIUM ALLOYS. ANALYSIS AND CONTROL IN THE "ATTILA" PRODUCTION LINE. Mantega, M.; Marlin, H.; Manevy, G. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). [nd]. 23p. (In French). (CONF-681040-10). Dep.

From Symposium on Nonaqueous Reprocessing, Mol, Belgium.

Treatment of fuel assemblies of U–Zr or Al–U alloys at the ATTILA installation involves the volatilization of their fluorides. The process includes chlorination of the fuel assembly by hydrochloric acid and pyrohydrolysis of $ZrCl_4$ or $AlCl_3$. UCl_3 and fission product chlorides, which have not been volatilized during the preceding phase, are fluorinated. Selective desorption of UF_6 fixed on NaF precedes recovery of the product by sublimation. (J.G.B.)

13817 (CEA-CONF-1194) TREATMENT OF ENRICHED URANIUM ALLOYS. FIRST OPERATING RESULTS OF THE "ATTILA" FACILITY. Rochedereux, Y.; Perrot, M.; Mantega, M.; Manevy, G.; Bourgeois, M. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). [1968]. 36p. (In French). (CONF-681040-11). Dep.

From Symposium on Nonaqueous Reprocessing, Mol, Belgium.

The design of the ATTILA installation is described, along with studies that were made on Al clad–U alloys and Zircaloy clad U–Zr alloys. The method for processing the alloys consists of attack by HCl in a fluidized bed of alumina at 300 to 400°C. The Zr or Al is transformed in volatile chloride which is converted to oxide by water vapor at 400°C in a fluidized bed of silica. The U that remains in the alumina bed in the state of nonvolatile chloride is finally transformed into hexafluoride by fluorine at 100 to 500°C. UF_6 is purified by absorption-desorption on some NaF pellets. UF_6 desorbed at 400°C by fluoride scavenging is trapped in a cold condenser at −80°C. (P.C.H.)

13818 (CEA-CONF–1195) TREATMENT OF FUEL BY THE DRY METHOD. STUDIES PERFORMED IN FRANCE. Bourgeois, M.; Faugeras, P. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). [1968]. 7p. (In French). (CONF-681040–9). Dep.

From Symposium on Nonaqueous Reprocessing, Mol, Belgium.

Methods for treatment of fuels of uranium-base alloys and PuO_2–UO_2, based on the selective volatilization of UF_6 and PuF_6, are described. Mechanical and chemical decladding procedures and economic aspects of the treatment are included. (J.G.B.)

13819 (CEA-CONF–1197) TREATMENT OF BREEDER REACTOR FUEL. SEPARATION OF HEXAFLUORIDES OF URANIUM AND PLUTONIUM. Manevy, G.; Bourgeois, M. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). [1967]. 26p. (In French). (CONF-681040–4). Dep.

From Symposium on Nonaqueous Reprocessing, Mol, Belgium.

The separation of U–Pu from a mixture of their hexafluorides was studied by volatilization of fluorides for two types of fuels. Selective thermal decomposition of PuF_6 was used for the elimination of PuF_6 traces from UF_6. No attempt was made to recover Pu. The second type fuel was a mixture of PuO_2–UO_2 from breeder reactors from which Pu was recovered by selective reduction of PuF_6 into the tetrafluoride by different chemical reagents. (P.C.H.)

13820 (HW–63453) PUREX TWO-CYCLE WASTE STUDIES. McKenzie, T. R. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Nov. 16, 1959. Contract AT(45-1)-1350. 18p. Dep. CFSTI.

Laboratory studies of the effect of reflux, radiation, and solution composition upon Purex waste concentration were carried out. Starting with fresh combined waste (a composite of Purex wastes containing 5.72M sodium ion) a sludge temperature of 120°C results when the waste is concentrated to about 16 to 17M sodium. Simulated reflux, accomplished by concentrating a waste sample, diluting with fresh combined waste, and reconcentrating, produced a sludge that achieved temperatures of 120°C at less than 10M sodium ion. Radiation had much the same total effect on the boiling characteristic of combined waste, as simulated reflux. Combined waste irradiated to an average total dose of 5×10^7 R gamma in a Co^{60} source could be concentrated only to a point corresponding to 11M sodium before a sludge temperature of 120°C was reached. Starting with fresh, combined waste, a variance in concentration of sulfate from 0.0 to 1.0M, or aluminum from 0.0 to 0.4M, had no significant effect on the behavior of the waste. Likewise, no major effect was noted when the NC_2^-/NO_3^- ratio in the waste was varied from 0 to 6. A variance in initial iron(III) concentration, however, produced major changes in the boiling characteristics of combined waste. Iron-free waste can be concentrated to about 23M sodium before excessive sludge temperature results. Combined waste containing 0.1 and 0.45M iron(III) reached sludge temperatures of 120°C during concentration, at 17 and 13M sodium, respectively. Simulated reflux, total reflux for 5 hours, or radiation caused coagulation and/or dehydration of the precipitates such that sludge settling rates, compared to untreated combined waste, were increased by factors of 2 or more. These data lead to the conclusion that reflux and intense radiation are major contributing factors in the accumulation of sludge layers in the waste tanks. This sludge layer, primarily iron(III) hydroxide, tends to scavenge the fission products from the waste, thus concentrating the heat source in the sludge layer. The combination of a partially immobile sludge and a high heat source result in high temperatures unless the waste is maintained in a fairly dilute state. (auth)

13821 (HW–71145) EVAPORATION OF PUREX ORGANIC WASH WASTE SOLUTION. Sorenson, R. J. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Sept. 3, 1961. Contract AT(45-1)-1350. 9p. Dep. CFSTI.

It was proposed that organic wash waste from the Purex Process be concentrated before storage. A laboratory program was undertaken to provide the necessary analytical information and to investigate the boil-down characteristics of the waste stream. The concentrated bottoms from the process will be stored in existing nonboiling tanks and the condensate will be cribbed or swamped, depending on the decontamination achieved. A reduction in waste volume of greater than 20-fold appears attainable. Volume reductions up to 28-fold yielded residues that were readily transferred. (M.C.G.)

13822 (HW–71789) FUTURE PUREX (1WW) WASTE CHARACTERISTICS. Sorenson, R. J. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Nov. 29, 1961. Contract AT(45-1)-1350. 22p. Dep. CFSTI.

The synthetic Purex 1WW used in the study initially had a very slight amount of soft gelatinous precipitate. Denitrating with formaldehyde (D1WW) resulted in about 8.2% solids, and neutralizing (ND1WW) to a pH of greater than 9.5 with sodium hydroxide resulted in approximately 70% solids. Both sludges were readily suspended with moderate agitation. A plot of the calculated sodium molarity vs. the boiling temperature during concentration is roughly linear. Excursions previously observed were believed due to superheating of the sludge. During the course of this work, no superheating of the sludges or supernates was apparent. Dilution and reconcentration of the concentrated ND1WW resulted in no significant difference compared to the first concentration. Varying the sulfate and iron concentration had little or no significant effect on the behavior of the waste. The effect of irradiation was not studied. (auth)

13823 (HW–75732) PUREX CONCENTRATOR CORROSION LEVELS. Oberg, G. C. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Nov. 30, 1962. Contract [AT(45-1)-1350]. 11p. Dep. CFSTI.

Analysis of sample data obtained from Purex waste streams during May, June, August, and October operating periods indicates high concentrator corrosion rates during the May-June period of 85 to 230% above normal. The corrosion rate of 4.5 lb/TU as shown by the August samples correlates well with previous estimates of iron in the IWW and is considered "normal" for two-stage waste concentration. October samples point out a 50% reduction from "normal" in corrosion iron as a result of changing to single-stage waste concentrator. Concentrator corrosion rates are estimated to be 0.8 to 1.3, 3.7, and 1.5 lb/T, respectively, for the E-H4 and J8, E-F11 and F6, and E-F6 Concentrators. Since process conditions in E-J8 Concentrator are such that corrosion is low, the majority of the 0.8 to 1.3 lb/TU corrosion iron can be assigned to E-H4. It is not possible to state with certainty the corrosion iron distribution between the E-F6 and E-F11 Concentrators during two-stage operation so that corrosion rates of 1.5 to 2.2 lbs/TU can be ascribed to E-F11 during periods of "normal' (4.5 lbs/TU) iron in the IWW with corresponding E-F6 corrosion rates of 2.2 and 1.5 lb/TU. The period of greater-than-normal iron in the IWW started after the failure of the E-F11 concentrator in January 1962 and presumably resulted from extremely severe corrosion in the E-F11 replacement concentrator. (auth)

13824 (IN–1201) CHEMICAL TECHNOLOGY BRANCH ANNUAL REPORT, FISCAL YEAR 1968. Bower, J. R. (ed.) (Idaho Nuclear Corp., Idaho Falls). Oct. 1968. Contract AT(10-1)-1230. 150p. Dep. CFSTI.

Research progress is reported on performance of ICPP fuel recovery processes, support studies for current ICPP fuel recovery processes, electrolytic dissolution process for EBR-II fuel, graphite fuel reprocessing, zirconium oxide fuel reprocessing, operating experience in the Idaho waste calcining facility,

studies supporting the calcination of fluoride-containing zirconium wastes in the WCF, study of calcination using in-bed combustion of fuel for heating, supporting studies for other possible waste calcining facility improvements, additional waste management studies, LOFT assistance program, and other reactor technology support programs. (M.C.G.)

13825 (LS-70(Pt.2)) TRIBUTYL PHOSPHATE (TBP) AND ITS APPLICATION IN SOLVENT EXTRACTION. An Annotated Bibliography. Wallach, K. S. (comp.) (Israel Atomic Energy Commission, [Tel Aviv]). Jan. 1963. 215p. Dep.

See also LS-70(Pt.1) abstracted previously as NSA 22: 12401. References (354) are given to journals, reports, patents, and conference papers published from 1949 through 1960. Separate author, subject, and report number indexes are included. (P.C.H.)

13826 (NSJ-tr-144) FUNDAMENTAL STUDIES ON THE ION EXCHANGE SEPARATION OF ISOTOPES. IX. SEPARATION FACTOR OF URANIUM ISOTOPES. (3). Gonda, Kozo; Kawashima, Nobuyoshi; Kakihana, Hidetake. Translated from Nippon Genshiryoku Gakkaishi, 9: 376-81(July 1967). 12p. Dep.

An abstract of this paper, prepared from the original language, appeared as NSA 21: 40982.

13827 (ORNL-4348) THE EXTRACTION OF PLUTONIUM(VI) FROM NITRIC ACID–URANYL NITRATE SOLUTIONS WITH TRI-n-BUTYL PHOSPHATE. Moore, John G. (Oak Ridge National Lab., Tenn.). Jan. 1969. Contract W-7405-eng-26. 35p. Dep. CFSTI.

As part of a program aimed at the development of aqueous processes for recovering uranium and plutonium from spent fast reactor fuels, data were obtained for the extraction of Pu(VI) with 14.2 vol % TBP in n-dodecane from 1, 2, 3, and 4 M HNO_3 solutions having plutonium concentrations of 1 to 10 g/liter and uranium concentrations of 0 to 100 g/liter. When the concentration of metal in the organic phase was low, coefficients for the extraction of Pu(VI) from 2, 3, and 4 M HNO_3 solutions were 0.9, 1.3, and 1.6, respectively, as compared to coefficients of 2, 4, and 7 for Pu(IV). The Pu(VI) coefficient decreased to about 0.1, and the Pu(IV) coefficient decreased to 0.2–0.4, when the metal concentration in the organic phase was increased to 50 g/liter (about 80% of saturation). Because of these low coefficients and the large concentration of plutonium involved, a countercurrent extraction system must be operated at moderate organic-phase metal loadings to prevent excessive reflux of plutonium between the scrub and the extraction sections. Coefficients for the extraction of Pu(VI) with 5 to 30 vol % TBP from 2 M HNO_3 solutions were proportional to about the 1.4th power of the TBP concentration. (auth)

13828 (ORNL-TM-2294) WASTE TREATMENT AND DISPOSAL SEMIANNUAL PROGRESS REPORT, JULY–DECEMBER 1967. Blanco, R. E.; Cowser, K. E. (Oak Ridge National Lab., Tenn.). Jan. 1969. Contract W-7405-eng-26. 134p. Dep. CFSTI.

Research progress is reported under the following headings: treatment of high-level radioactive waste; treatment of intermediate-level radioactive waste; engineering, economic, and safety evaluation; separation of noble gases from air using permselective membranes; disposal in natural salt formations; safety evaluation of waste management system; disposal by hydraulic fracturing; and fate of radionuclides in terrestrial environment. (M.C.G.)

13829 (ORNL-TM-2428) SEPARATION OF BERKELIUM FROM TRIVALENT ACTINIDES BY CHROMATE OXIDATION AND HDEHP EXTRACTION. Knauer, J. B.; Weaver, Boyd (Oak Ridge National Lab., Tenn.). Nov. 14, 1968. Contract W-7405-eng-26. 30p. Dep. CFSTI.

The extraction of ^{144}Ce by organic phases of varying HDEHP concentrations from nitric acid media of varying concentrations containing varying concentrations of oxidizing agents, i.e., $NaBrO_3$ and/or CrO_3, is discussed. The extraction of ^{249}Bk under similar aqueous and organic phase conditions as used for ^{144}Ce extractions is described. Procedures for stripping the extracted ^{144}Ce or ^{249}Bk are discussed. Results of the actual separation of ^{244}Cm from ^{249}Bk are also given. Finally, a process for the separation of ^{249}Bk from the other transplutonium elements is proposed. (auth)

13830 CONCENTRATION OF ALL RARE EARTH IMPURITIES OF CERIUM SUB-GROUP RARE EARTH MATRICES. Molnar, F.; Lebedev, N. A. (Central Research Inst. for Physics, Budapest. Joint Inst. for Nuclear Research, Dubna, USSR). J. Radioanal. Chem., 2: 91-5(Jan. 1969).

The separability of all rare earth impurities from cerium subgroup matrices was investigated. It was found that anion exchange chromatography carried out with aqueous methanol solutions of nitrates provides a useful method for the concentration of all rare earth impurities in neodymium and gadolinium matrices. The concentrate of the impurities can be processed further as required by the method chosen for their analytical determination. (auth)

13831 THE SPECIFIC EXTRACTION OF URANIUM(VI) WITH N-BENZYLANILINE AND N-BUTYLANILINE. Gagliardi, E.; Ilmaier, B. (Univ., Graz). Mikrochim. Acta, No. 6, 1259-68 (1968). (In German).

Two methods for the extractive separation of uranium from a number of ions are described. The extraction is from a solution containing sulfuric acid by means of N-benzylaniline or N-butylaniline, dissolved in chloroform. After reextraction with water, there follows the quantitative determination with pyridylazoresorcinol (PAR). (auth)

13832 TESTING OF INSTALLATIONS FOR PURIFICATION OF THE AIR: ASSAY OF CONFORMITY OF THE ELEMENTS; TESTS IN SITU. Billard, Francois; Brion, Jacques. pp 1543-50 of Radiation Protection. Part 2. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968. (In French).

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.2)).

The operational safety of air purification installations is a function of the controls to which these installations are submitted. If the in situ tests are the most important since they constitute the final control of the finished installation, conformity tests of the constituent elements are also important. They permit elimination of defective elements before they are installed and the discrimination of mounting defects from those of the element. The different controls for aerosol filters and for iodine traps are described. The characteristics verified are the nature of the materials, the dimensions of the elements, efficiency, charge loss, mechanical resistance, inflammability, humidity behavior, temperature behavior, resistance to decompression of the iodine trap, friability of the absorbent material, etc. With respect to iodine trap installation, test trap control working in parallel with the principal trap is provided. This simple control makes it possible to reduce the frequency of the in situ tests, particularly when it is a question of detecting an eventual poisoning by organic vapors. (tr-auth)

13833 SEPARATION OF RADIOACTIVE IODINE IN RESPIRATORY FILTERS. Hacke, J.; Jacobi, W. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). pp 1575-83 of Radiation Protection. Part 2. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968. (In German).

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.2).

The filtration of radioiodine in respiratory filters (fiber and activated charcoal) was investigated with the help of the multifilter method. The various filterless iodine components in the air can be separated and their fractions determined. Elementary iodine and iodine deposited on aerosol particles were almost completely retained in the filter. For a third weak iodine component, in which it is probably preponderantly methyl iodine, the filter is relative permeable. The fraction of this component increased in inverse proportion to the I concentration in the air and was, at a specific ^{132}I activity of the air of approximately 10^{-4} Ci/m^3, about 0.03%; a total iodine permeability of the respiratory filter of 0.02% was then obtained. The suitability of the instrument for special applications is discussed. (tr-auth)

13834 AGENT FOR TREATING RADIOACTIVE LIQUID WASTES. Miyashita, Isao (to Hokkaido Colliery and Steam-Ship Co., Ltd.). Japanese Patent 1968-20960. Sept. 7, 1968. Filed July 10, 1965.

Substances, such as humic acid, that are obtained by oxidation–dissociation of coals in aqueous media with molecular oxygen gas or gases containing it are proposed for treatment of radioactive wastes. (NSA of Japan)

13835 MULTI-STAGE SEPARATION OF COMPONENTS OF A SOLUTION. Godfrey, Wesley L. (to United States Atomic Energy Commission). U. S. Patent 3,424,549. Jan. 28, 1969.

A "batch-continuous" process for separation of constituents of a solution is applicable to crystallization, ion exchange or solvent extraction. A series of vessels is utilized, which overflow from one to the other and which discharge liquid at both ends of the series. Feed is introduced at one end of the series and wash solution at the other. By a repetitive series of steps involving phase changes, introduction of feed and introduction of solvent, one constituent is caused to discharge at one end of the series and one at the other. The process is adapted to use in a remotely operated and maintained plant. (AEC)

13836 PROCESS FOR DEPLETING ^{17}O AND ^{18}O IN $^{238}PuO_2$. Porter, John A. (to United States Atomic Energy Commission). U. S. Patent 3,420,640. Jan. 7, 1969.

A process is described for preparing $^{238}PuO_2$ having a low neutron emission rate by depleting the oxide in ^{17}O and ^{18}O isotopes. Solid phase $^{238}PuO_2$, having a natural abundance of oxygen isotopes, is heated to about 700°C and is contacted with water vapor (steam) that is depleted in ^{17}O and ^{18}O to effect an exchange of oxygen isotopes. The resulting $^{238}PuO_2$ is depleted in ^{17}O and ^{18}O isotopes and has a low neutron emission rate. (AEC)

13837 CHELATE FORMING EXCHANGE RESINS. VII. CHELATE EXCHANGER OF 1,8-DIHYDROXYNAPHTHALENE-O,O-DIACETIC ACID FOR SEPARATION OF ZIRCONIUM FROM HAFNIUM AND OTHER ELEMENTS. Blasius, E.; Kynast, G. (Univ. des Saarlandes, Saarbruecken, Ger.). J. Radioanal. Chem., 2: 55-71(Jan. 1969). (In German).

Preparation and use of a resin with 1,8-dihydroxynaphthalene-O,O-diacetic acid as chelating group are described. Besides the separation of many of the common interfering ions it also permits the separation of Hf. The following ions could be separated quantitatively: Mg(II), Pb(II), Cu(II), Fe(III), La(III), Ce(IV), Th(IV), Ti(IV), and U(VI). During these and further qualitative and quantitative experiments no interfering ions could be found. A method for the separation of ^{95}Zr from its daughter nuclide ^{95}Nb is also described. The main problem proved to be the separation of Zr(IV) and Hf(IV), owing to their close resemblance. To accomplish quantitative determination of Zr and Hf without any separation, ^{95}Zr and $^{175+181}Hf$ radioisotopes were used. The chelating resin permits the separation of 95% of Hf(IV) from an equimolar solution. The main part of Hf(IV) is eluated by 2 M hydrochloric acid, and subsequently Zr(IV) by 0.75 M oxalic acid. The rest of Hf is enriched in the first fractions of the oxalic acid eluate, so that when eliminating these, even after a single step experiment hafnium free from zirconium and a rather pure fraction of zirconium are obtained. Even under extreme conditions of concentration (Zr : Hf = 91 : 1) 75% of Hf can be separated free from Zr in a single step experiment. (auth)

13838 DISTRIBUTION OF SULPHURIC ACID BETWEEN TRI-n-BUTYL PHOSPHATE AND WATER. Hanson, C.; Patel, A. N. (Univ. of Bradford, Eng.). J. Appl. Chem. (London), 19: 20-4(Jan. 1969).

The distribution of sulphuric acid between water and 40 vol. % solutions of tri-n-butyl phosphate (TBP) in six diluents, and also between water and 40, 60, and 80% solutions of TBP in cyclohexane at 20°C, and between water and 40% solution of TBP in cyclohexane and pure TBP at 20, 30, and 50°C was studied to find the effects of temperature, diluent, and TBP concentration on the extractability of sulphuric acid and on "third-phase formation." (auth) (UK)

13839 RECOVERY OF PLUTONIUM FROM NON-IRRADIATED REFRACTORY PLUTONIUM AND URANIUM–PLUTONIUM OXIDES, NITRIDES, AND CARBIDES. Maurice, M. J.; Fischer, J.; Kramer, G. N. (EURATOM, Karlsruhe, Ger.). J. Appl. Chem. (London), 19: 15-17(Jan. 1969).

In the recovery of plutonium from high-fired uranium–plutonium oxides dissolution is the most critical step. It was found that 100% solid solutions of uranium–plutonium oxides are readily soluble in 14 M nitric acid. A procedure was developed to convert any mixed oxide completely into a solid solution, so that dissolution is faster than the usual direct dissolution in nitric acid–hydrofluoric acid. The use of the latter acid is thus avoided. Nitrides and carbides are oxidised to oxides, which are subsequently dissolved in pure concentrated nitric acid. Detailed procedures are given. (auth) (UK)

13840 PROGRESS IN SEPARATION AND PURIFICATION. VOLUME 1. Perry, Edmond S. (ed.). An Interscience Series. New York, John Wiley and Sons, Inc., 1968. 399p. $16.50.

The book includes 9 chapters dealing with various aspects of separation processes and entitled: principles of foam extraction; normal freezing; preparative gas chromatography; zone refining of chemical compounds; membrane permeation; separation and purification of plasma proteins; purification of zirconium by a dry process; ultrafiltration; and gas and vapor separation by means of membranes. Separate abstracts have been prepared for three chapters. (B.L.M.)

For abstracts of individual chapters see: 13841–13843.

13841 PRINCIPLES OF FOAM FRACTIONATION. Lemlich, Robert (Univ. of Cincinnati). Progr. Separ. Purif., 1: 1-56 (1968).

Foam fractionation is a method for partially separating the components of a solution by virtue of differences in the surface activities and is applicable to the removal of trace radioactive cations from solutions. This chapter deals primarily with the principles of foam fractionation. Fifty-one references are cited. (B.L.M.)

13842 PURIFICATION OF ZIRCONIUM BY A DRY PROCESS. CHEMICAL SEPARATION OF HAFNIUM FROM ZIRCONIUM. Frampton, Orville D.; Feldman, Julian (U. S. Industrial Chemical Co., Cincinnati). Progr. Separ. Purif., 1: 247-95(1968).

Various methods for Zr purification and separation from Hf are reviewed. The dry chemical methods, which result in the direct production of $ZrCl_4$ sponge, have advantage over other methods because reconstitution of dissolved Zr salts to the anhydrous $ZrCl_4$ is avoided. The chemistry of the Zr and Hf halides is reviewed. Using the observation that different temperatures have been reported for the reduction of $ZrBr_4$ and $HfBr_4$ with Al and the established chemistry of the trihalides of Zr and Hf, a vacuum bench-scale process was developed for purification of Zr. Yields of $ZrCl_4$ of 90% having less than 100 ppM of Hf can be obtained in a two-stage operation with head recycle. (B.L.M.)

13843 GAS AND VAPOR SEPARATIONS BY MEANS OF MEMBRANES. Kammermeyer, Karl (Univ. of Iowa, Iowa City). Progr. Separ. Purif., 1: 335-72(1968).

Only material dealing with new concepts, reference to permeability data for both polymeric and microporous media, effects of operating variables on permeability and flow mechanisms, and computer use in iterative calculations for cell performance is included. The use of barriers to separate gas and vapor mixtures is discussed under the categories of microporous barriers and nonporous media, and in each category most of the work discussed is experimental-scale work. (B.L.M.)

13844 EXPERIMENTAL VERIFICATION, WITH KRYPTON, OF THE THEORY OF THE THERMAL-DIFFUSION COLUMN FOR MULTICOMPONENT SYSTEMS. Roos, W. J.; Rutherford, W. M. (Monsanto Research Corp., Miamisburg, Ohio). J. Chem. Phys., 50: 424-9(Jan. 1, 1969).

Thermal-diffusion column transport equation coefficients were measured for the multi-isotope gas krypton. Measurements were made in a column of the hot-wire type for both static and flow conditions, at hot-wire temperatures of 623, 773, and 1073°K. The agreement between the theoretical and experimental values of the coefficients was reasonably good in all cases. The average ratio of the experimentally determined values of the reduced initial transport coefficient to the theoretically calculated value was 1.09 ± 0.11; the similar average ratio for the convective remixing coefficient was 1.11 ± 0.12; the average ratio for the diffusive remixing coefficient was 1.04 ± 0.06. The theoretical prediction that the reduced initial transport coefficient should be independent of the choice of isotope pair was also verified. (auth)

13845 APPLICATION OF A SODIUM AMALGAM FOR RAPID SEPARATION OF CARRIER-FREE RADIOACTIVE RARE EARTH ISOTOPES. Novgorodov, A. F.; Khalkin, V. A. Radiokhimiya, 10: 554-7(1968). (In Russian).

A sodium amalgam was used for rapid separation of genetically bound pairs of carrier-free rare earth isotopes in an acetate buffer solution. These pairs included: $^{167}Yb–^{167}Lu$, $^{164}Yb–^{164}Tm$, $^{142}Sm–^{142}Pm$, and $^{149}Tb–^{145}Eu$. This method was also used for separation of carrier-free $^{151,153}Gd$ from gram targets of europium oxides, irradiated with protons at 10 MeV. (tr-auth)

13846 SOLVENT EXTRACTION OF NEPTUNIUM WITH 1-PHENYL-3-METHYL-4-BENZOYLPYRAZOLONE-5. Novikov, Yu. P.; Palei, P. N.; Margorina, M. N. At. Energ. (USSR), 26: 66-7(Jan. 1969). (In Russian).

Separation of neptunium from plutonium and extraction of Np by 1 phenyl-3-methyl-4-benzoylpyrazolone-5 (PMBP) were studied. Tabulated data on neptunium extraction from 0.1M nitric acid solutions by PMBP in benzene and dichlorethane show that the equilibrium was reached within one minute and Np(IV) was extracted by PMBP in benzene up to 5N HNO_3. Experiments with extraction of Np(IV) by PMBP solutions in benzene and dichloroethane showed complete Np extraction from 3N HNO_3 during its concentration of 0.84×10^{-4} g/atom/l and PMBP concentration starting with 0.03M. Data also showed that oxalates, acetates, phosphates, and ascorbic acid do not influence Np(IV) extraction. Neptunium(IV) re-extraction from PMBP can be achieved with 15N H_2SO_4, 9N HCl, 0.9M oxalic acid solution, and 0.1M OEBPA. The radiometric determination of neptunium also can be used for separating Np preparations from plutonium. (R.V.J.)

13847 STABILITY TRENDS FOR THE LANTHANIDES ON DOWEX A-1 CHELATING RESIN. Lang, C. E. (Loras Coll., Dubuque, Iowa); Schrobilgen, G. J. Proc. Iowa Acad. Sci., 74: 54-60(1967).

Distribution coefficients were determined for a number of trivalent lanthanide ions on an ion exchange resin containing N-benzyliminodiacetic acid groups. At pH 2.00, μ = 0.100 and 25.00°G. the relative stability trends for lanthanum through neodymium were found to be in agreement with trends previously observed with iminodiacetic acid, N-methyliminodiacetic acid, and N-benzyliminodiacetic acid. Beyond neodymium the distribution coefficient sequence of lanthanide–resin chelates is inverted. On the basis of the distribution coefficients, the inverted elution sequences previously reported in the literature for lanthanum and lutetium on the resin can be explained. A number of plausible explanations for the trends observed can be offered, among which are steric effects, changes in coordination number and electrostatic repulsive effects. Infrared spectral data indicate the existence of a zwitterionic lanthanide chelate species which may contribute to the latter effect. (auth)

13848 DEPENDENCE OF COEFFICIENT OF PURIFICATION ON THE pH DURING EVAPORATION OF WEAKLY RADIOACTIVE WASTE WATERS. Shvedov, V. P.; Yakushev, M. F.; Permyakov, A. A.; Popov, V. I. Radiokhimiya, 10: 749-52 (1968). (In Russian).

The coefficient of purification of an evaporizer depends considerably on the pH of evaporated solution. With the activity of cubic residue 2×10^{-6} Ci/l and pH = 6 to 7, the coefficient for ^{137}Cs reached 3 to 5×10^{4}, and could be increased for ^{137}Cs and ^{90}Sr by order of one by eliminating foaming. Variations of the phlegm number by 5 to 10% at pH < 7 does not affect the efficiency (R.V.J.)

13849 SEPARATION OF Sm^{3+}, Eu^{3+}, AND Yb^{3+} FROM ELEMENTS OF THE CERIUM SUBGROUP. Shvedov, V. P.; Frolkov, A. Z.; Kornilov, K. G. Radiokhimiya, 10: 736-8(1968). (In Russian).

Tabulated data are given on separation of Sm^{3+}, Eu^{3+}, and Yb^{3+} from cerium subgroup elements by reduction using sodium amalgam with some cesium acetate admixture. The data obtained on separation of Eu^{3+} and La^{3+} showed complete transition of Eu^{3+} into the amalgam while La^{3+} was not reduced. With an increased amount of Eu^{3+} the separation improved. Table of Sm^{3+} and Pr^{3+} pair separation using ^{143}Pr showed a complete transition of Sm^{3+} into amalgam and complete retention of Pr^{3+} in the solution. Results for the Yb^{3+} and Pr^{3+} pair showed that Yb^{3+} was easily reduced and transmitted into amalgam while Pr^{3+} remained in the solution. Separation of the pairs in the sodium amalgam without cesium acetate was much less successful. (R.V.J.)

13850 SEPARATION OF La AND Ac BY THE METHOD OF DISTRIBUTIVE CHROMATOGRAPHY. Ziv, D. M.; Shestakov, B. I.; Shestakova, I. A. Radiokhimiya, 10: 738-40(1968). (In Russian).

Separation of ^{140}Ba, ^{140}La, and ^{228}Ac ($MgTh_2$) by distributive chromatography with an inverse order of elution from 100% tributyl phosphate using eluting solutions of 10M NH_4NO_3 + 0.1M HNO_3 and 0.1M HNO_3. The rate of elution was 0.14 ml/min. The curves of Ba, La, and Ac separation are given. (R.V.J.)

13851 SEPARATION OF NUCLEAR TELLURIUM ISOMERS USING THEIR INORGANIC DERIVATIVES. Sinotova, E. N.; Timofeev, S. A. Radiokhimiya, 10: 758-60(1968). (In Russian).

Separation of nuclear tellurium isomers using inorganic derivatives was studied using thin-layer chromatography and the relation between the yield of the tellurium isomer in the ground state (Te(IV)) and acidity of the media. Telluric acid, $H_2TeO_4 \cdot 2H_2O$, and its ammonium salt, $(NH_4)_2TeO_4 \cdot 2H_2O$, were used as initial inorganic derivatives. Transition of ^{127m}Te → ^{127}Te in telluric acid and ammonium tellurate stabilized the ground state ^{127}Te in the tetravalent form. (R.V.J.)

EARTH SCIENCES

Geology and Hydrology

Refer also to abstracts 13740, 13812, 13828, 13870, 13895, 13897, 13900, 13992, 14059, and 14061.

13852 (BNWL-859) EFFECT OF DETERGENTS ON ADSORPTION OF RADIONUCLIDES BY SOIL. Knoll, K. C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan. 1969. Contract AT(45-1)-1830. 6p. Dep. CFSTI.

The uptake of ^{137}Cs and ^{85}Sr by soil from decontaminating solutions containing detergents was studied. Seven detergents were used in the study, each at two levels of concentration. In general, the adsorption of ^{137}Cs by soil was impaired in the presence of detergents. Adsorption of ^{85}Sr by soil from solutions containing detergents was equal to or better than the adsorption by soil in the absence of detergents. Any changes which occurred were more pronounced at higher concentrations. (auth)

13853 (BNWL-951) A SURVEY OF HEAT SINK CAPACITY OF MAJOR STREAMS WITHIN THE U. S. Wise, K. R.; Cole, B. M. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan. 1969. Contract AT(45-1)-1830. 61p. Dep. CFSTI.

The supply of cooling water has always been an important consideration in the selection of sites for power plants. As power requirements increase, the availability of cooling water is becoming an increasingly important concern in power generation forecasts. Data indicative of the limitations of the cooling water supply in the nation are presented. As an index of cooling potential for each major stream, heat input for a one degree F temperature rise, with the minimum monthly average flow recorded in a ten year period, is used. Based on this characteristic of the streams in the U.S. an attempt was made to identify, on a regional basis, where alternate solutions to once-through cooling can be anticipated first. Water quality standards will also affect cooling water availability. An attempt was also made to identify the potential impact of these standards. (auth)

13854 (BNWL-984) RADIOLOGICAL STATUS OF THE GROUND WATER BENEATH THE HANFORD PROJECT, JANUARY-JUNE 1968. Essig, T. H. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan. 6, 1969. Contract AT(45-1)-1830. 20p. Dep. CFSTI.

An evaluation of the status of the Hanford Area ground water contamination resulting from disposal of plant effluents is presented. The data were collected during the first six months of 1968. Total beta concentrations in the unconfined and confined ground water aquifiers are presented. Results are tabulated for well-water samples in which total beta concentrations exceeded the analytical limit. (R.C.K.)

13855 (EUR-4095) REMEDIAL ACTIONS IN CASE OF GROUNDWATER CONTAMINATION OF SANDY AQUIFERS, 1966. Final Report. Baetsle, L. H.; de Laguna, W.; Soufriau, J. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). Aug. 22, 1968. 54p. Dep.

Hydrogeologic investigations on the SCK-CEN site at Mol, Belgium, have shown that the water table aquifer is made up of two sandy formations with different permeability and partly sealed from the underlying aquifer by a succession of tiny impermeable layers. The removal of non-adsorbed radioactive contamination from the underground by pumping, called "scavenging", follows the classical pattern of pumping from a water table under the condition that the two layers with permeabilities 1.12 cm/min and 0.56 cm/min and their respective thicknesses are considered. By injecting HF and $K_2H_2Sb_2O_7$ into the aquifer a chemical barrier is formed which is specific for Sr tests on the penetration of reagents tagged with ^{82}Br into the aquifer have indicated that 1.5 to 2 void volumes are sufficient in order to replace all the interstitial fluid by reagent. Zones with different permeability have to be treated separately. The delay coefficient of the chemical barrier installed in the water table aquifer at Mol amounts to 20, i.e., the Sr moves twenty times slower than the groundwater. (auth)

13856 ^{90}Sr CONTENT OF SOILS NEAR CAPE THOMPSON, ALASKA. Holowaychuk, N.; Gersper, P. L.; Wilding, L. P. (Ohio State Univ., Columbus). Contract AT(11-1)-414. Soil Sci., 107: 137-44(Feb. 1969). (COO-414-5).

Annual levels of ^{90}Sr in soils near Cape Thompson, Alaska, were studied. Strontium-90 distribution as related to soil type and factors responsible for the distribution were evaluated. The increase in ^{90}Sr burdens in soils from 1961 to 1964 is thought to be caused by the 1961 nuclear weapons testing. A consistent correlation was not evident between soil characteristics and ^{90}Sr accumulation. Poorly drained soils seemed to accumulate more ^{90}Sr, as did soils in areas of higher rainfall. The rate of increase in ^{90}Sr content at different sites was not significantly different. Wind transported plant material debris enriched the accumulation. Deposition and accumulation appear to be the most important factors affecting fission product redistribution. (F.S.)

13857 METHOD FOR TAGGING SAND WITH A GASEOUS RADIOACTIVE ISOTOPE. Acree, E. H.; Case, F. N. (to United States Atomic Energy Commission). U. S. Patent 3,426,205. Feb. 4, 1969.

A process is described for tagging sand with a gaseous radioactive isotope to facilitate tracing and monitoring natural sand movements in coastal areas. The tagging is achieved by subjecting sand to an environment containing a gaseous radioisotope selected from ^{133}Xe, ^{82}Kr, ^{131}I, ^{125}I, and ^{37}Ar and heating the confined sand to effect sorption of the gaseous isotope into the sand. (AEC)

13858 SYSTEMATIC STUDY OF THE RADIOACTIVITY OF A DRAINAGE WATERWAY ORGANIZED ON AN INTERNATIONAL PLAN. Recht, P.; Collet, M. (European Atomic Energy Community, Brussels). pp 1337-41 of Radiation Protection. Part 2. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968. (In French).

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.2)).

In order to perfect the systematic study of the radioactivity of the whole of a river basin, the Euratom Commission, Director of Health Protection, has undertaken in the past few years a complete study of the proper methods and means to obtain the most representative results possible with respect to the radioactive pollution of the water course on the whole of a river basin. After establishment of a detailed program of research, the Rhine basin was selected because it interested the largest number of member states and because of its extent which makes it possible to take into consideration very diverse geological, climatic, industrial, and social elements. In order to make the general study of the radioactivity of the mud on the bottoms of the river and its principal affluences and at numerous points, a detailed study was made of the radioactivity of the waters, of the material in suspension, and of muds for a complete year; then for 42 points selected in an appropriate manner, the fixation capacity of the muds with respect to various radioelements was studied. This study of the total muds showed the necessity of investigating the fixation capacities for the various fractions of the mud with respect to the radioelements. The systematic studies of Ra and Sr were made on all the basin as well as in the waters and in the different components of the river mud. Parallel with this systematic study, which was carried out for several years, there was a general theoretical study which contributed to a better knowledge of the natural and artificial factors capable of affecting the contamination of the Rhine basin. All the data on the precipitation and radioactive fallout on the Rhine basin was collected in order to establish as exact a balance as possible for the period from 1962 to 1965, the years during which the study was carried out. The measurements and determinations were ended the first of March 1966. There is still the task of compiling and analyzing the numerous data collected and of presenting the results. It appears at present that the principles and methods adopted have resulted in valid results and can be applied to the study of other river basins. (tr-auth)

13859 ACCUMULATION OF RADIOACTIVE MATERIALS BY RIVER SILT. Collet, M. (European Atomic Energy Community, Brussels); Maushart, R.; Spaander, P. pp 1343-9 of Radiation Protection. Part 2. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968. (In German).

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.2)).

Within the framework of the studies on the radioactivity of the Rhine basin, the fixation capacities of the river silt for radioactive material was determined in order to draw conclusions on the deposition of fission products and other radioisotopes in the river bed. Therefore, the distribution coefficient C_p between river silt and river water (the ratio of the absorbed mass of the element studied per gram silt to the concentration of the same element in the water in equilibrium with the silt) was determined in the lab-

oratory for the elements Ce, Cs, I, P, Ru, and Sr. ^{141}Ce, ^{137}Cs, ^{131}I, ^{32}P, ^{103}Ru, and ^{89}Sr were used as the labeling isotopes. Altogether 756 individual samples were processed. These samples were separated by a centrifuge method into the three fractions sand, clay, and organic material, in order to obtain conclusions on the effect of the individual constituents of the silt. The methods were outlined, the results were reported, and the fixation capacities found were related to the activity of the individual fallout nuclides present in the silt. (tr-auth)

13860 FISSION TRACK AGES OF DEEP SEA GLASSES. Fisher, D. E. (Univ. of Miami, Fla.). Nature (London), 221: 549-50(Feb. 8, 1969).

The results of K:Ar dating measurements on deep sea basalts are briefly discussed. These results appear to indicate that excess Ar is a frequent component of deep sea rocks; such an excess means that the K:Ar ages must be regarded as maxima until the extent of the excess is determined. The presence of glass in terrestrial rocks is usually considered to indicate the possibility of Ar loss, so that the K:Ar ages of glassy materials may indicate only minimum ages. An independent means of dating these rocks was obviously desirable. Application of the fission track technique for age determination of samples of glass from the crust of basalt rocks is described. Results are tabulated for apparent K:Ar age, fossil fission tracks, fission track age, and ^{40}Ar excess. The observations are stated to open up the possibility of studying mantle-ambient rare gas abundances and composition. (UK)

13861 RADIOACTIVITY OF UPPER MESOZOIC GRAYWACKES IN THE NORTHERN COAST RANGES, CALIFORNIA. Wollenberg, Harold A.; Smith, Alan R. (Univ. of California, Berkeley). J. Geophys. Res., 72: 4139-50(Aug. 15, 1967). (UCRL-17061).

Traverses across the Coast Ranges north of San Francisco were made to measure the field gamma radioactivity and to sample graywackes of the Franciscan formation, its coastal belt unit and the great valley sequence. In the laboratory, specimens were analyzed for U, Th, and K by gamma spectrometry; K feldspar contents were determined by point-counting stained slabs. The K feldspar content has little effect on radioactivity or heat production of the rock units. Low K feldspar content does not indicate low heat generation; therefore, low-temperature high-pressure metamorphism is not related to K feldspar content. Radioactivity tends to decrease with increasing metamorphic grade. Thorium/uranium ratios fall within the range described by Adams and Weaver as typical of eugeosynclinal sediments and are like Th/U ratios in granitic rocks of the Sierra Nevada, the suggested source area. Uranium, thorium, potassium concentrations of the graywackes are compatible with those of a cratonal source. (auth)

13862 DIFFERENCES BETWEEN BARITES OF MARINE AND CONTINENTAL ORIGINS. Goldberg, Edward D. (Scripps Institution of Oceanography, La Jolla, Calif.); Somayajulu, B. L. K.; Galloway, James; Kaplan, I. R.; Faure, Gunter. Geochim. Cosmochim. Acta, 33: 287-9(Feb. 1969).

Uranium, thorium and strontium concentrations and strontium and sulfur isotopic ratios were determined on a group of barites. The isotopic analyses and the uranium and thorium concentrations appear to be especially diagnostic in distinguishing between marine and continental origins of the mineral. These critiques were applied to some barites recovered off the California coast. (auth)

13863 NUMERICAL SOLUTIONS OF RADIONUCLIDE TRANSPORT EQUATIONS. Armstrong, Neal E.; Gloyna, Earnest F. (Univ. of Texas, Austin). Chem. Eng. Progr., Symp. Ser., 64: No. 90, 47-58(1968).

Radionuclide transport in rivers in regard to instantaneous and continuous releases of these materials from nuclear reactors or processing plants is discussed. Because the fate of these radionuclides depends on hydraulics of river flow, physical sorption, chemical reactions, and biological uptake, few transport studies have considered more than one or two of these parameters at one time, and very few have attempted to assemble these relations into workable mathematical models. Hydraulic dispersion and physical sorption are considered as the two major influences in radionuclide transport. The measurement and modeling of dispersion have moved from one-dimensional models which consider vertical variations in stream velocity as the dispersion controlling agents to two-dimensional models with lateral velocities controlling dispersion. The one-dimensional model is adequate outside the initial dispersion zone, but a two-dimensional model is needed to model the initial distribution of instantaneous releases of radionuclides. The exact role which sorption plays in controlling net transport after instantaneous release in a river has not been carefully examined. Considerable data on the radionuclide contents of plants and sediments under essentially continuous release are available from studies in the Clinch River below the Oak Ridge National Laboratory in Tennessee and in the Columbia River below the Hanford Plant in Washington. The purpose of the study was to determine the sorption role of plants and sediment in the initial dispersion of an instantaneous release of a radionuclide, ^{85}Sr, to correct for their effect in calculating the dispersion coefficient, and to model observed dispersion curves by using the corrected dispersion coefficient and a numerical solution to the dispersion equation. The methods, results, and conclusions regarding these objectives are given. (auth)

13864 INFLUENCE OF NUCLEAR PLANT ON ITS REGION. Kawakami, Kooichi (Japan Atomic Industiral Forum, Inc., Tokyo). Genshiryoku Kogyo, 14: No. 12, 42-5(Dec. 1968). (In Japanese).

Problems encountered in the building of nuclear installations such as atomic power plants in Japan e.g., objections by the populace due to the possible radioactivity, and experiences of exposure to atomic bombs are discussed. To cool steam condensers in the power plants, Japan has to depend on seawater. Because the island country and the nation depends on the marine fisheries a problem exists when siting atomic power plants in the coastal areas. Such siting is also connected with the development of local areas. The situation in Japan is described in relation to a report of a Committee on the Problem of Sites in Japan Atomic Industrial Forum. (NSA of Japan)

13865 ISOTOPIC AGE DETERMINATIONS OF ROCKS AND MINERALS FROM THE BRITISH ISLES, 1965. A COMPILATION OF ABSTRACTS ORGANISED BY A COMMITTEE ON THE GEOLOGICAL SOCIETY OF LONDON. Quart. J. Geol. Soc. (London), 122: 443-59(June 1967).

This publication supplements that presented in Vol. 121, pp. 477-533 of the same journal. (UK)

13866 LEAD AND STRONTIUM ISOTOPE STUDIES OF THE BOULDER BATHOLITH, SOUTHWESTERN MONTANA. Doe, B. R. (Geological Survey, Denver); Hedge, C. E.; Tilling, R. I.; Klepper, M. R. Econ. Geol., 63: 884-906(Dec. 1968).

The isotopic composition of lead in feldspar varies widely from pluton to pluton of the Late Cretaceous Boulder batholith, encompassing the following ranges in isotopic values: 16.9 to 18.1 for $^{206}Pb/^{204}Pb$; 15.4 to 15.7 for $^{207}Pb/^{204}Pb$; and 37.7 to 38.5 for $^{208}Pb/^{204}Pb$. Although each pluton has a characteristic isotopic composition, the fact that $^{206}Pb/^{204}Pb$ for the Butte Quartz Monzonite varies by 1.3 percent, compared to a range of about 8.6 percent for the batholith as a whole, suggests that perfect isotopic mixing of the magma was not always attained. Whole rock initial $^{87}Sr/^{86}Sr$ for the entire batholith ranges from 0.705 to 0.710, comparable to ranges for the Sierra Nevada and British Columbia batholiths. Ore leads of the Butte district are isotopically very similar to feldspar leads of the host Butte Quartz Monzonite. This isotopic similarity was interpreted to indicate complete mixing of independently derived feldspar lead and ore lead rather than close genetic relationship. Lead and strontium isotope ratios generally behave in a similar way; that is, the more radiogenic the lead in a rock, the more radiogenic the strontium. The source of the lead which could produce the isotope variations observed for the batholith is calculated to have a mean age of about 2,200 my, which is compatible with ages of Precambrian crystalline rocks in the region, and an isotopic makeup with $^{238}U/^{204}Pb < 9$, $Th/U < 4$, and Rb/Sr of 0.03 to 0.09. Models involving complete melting of possible source materials to account for the isotope variations are considered and rejected. Mechanisms involving partial melting of lower crustal or upper mantle source material appear to be the most viable in explaining the observed isotopic compositions. (R.C.K.)

13867 VERTICAL DISTRIBUTION OF RADIOACTIVE FISSION PRODUCTS IN ACCUMULATION REGIONS OF AN ALPINE GLACIER (REMOTE VALLEY WALLS AND OTZTALER ALPS. Ambach, W.; Eisner, H.; Prantl, F. A. (Univ., Innsbruck). Acta Phys. Austr., 27: 46-9(1968). (In German).

Investigations of the vertical distribution of radioactive fission products in the accumulation region of an Alpine glacier show characteristic activity changes which can be used as references for the dating of firn layers. The extent to which comparable activity profiles could be obtained within the annual accumulation 1960/61 up to 1963/64 in the accumulation region of the remote valley walls was investigated. Secondary effects on the vertical distribution of the fission products, such as transport by melting or rain water, as well as adsorption effects on the dirt layers are determinative for the profiles. (tr-auth)

Meteorology

Refer also to abstracts 13668, 13669, 13828, and 13926.

13868 (BNWL-931) PLUTONIUM RELEASE STUDIES. IV. FRACTIONAL RELEASE FROM HEATING PLUTONIUM NITRATE SOLUTIONS IN A FLOWING AIR STREAM. Mishima, J.; Schwendiman, L. C.; Radasch, C. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Nov. 1968. Contract AT(45-1)-1830. 43p. Dep. CFSTI.

The fraction of plutonium released as an aerosol upon heating solutions of plutonium nitrate or plutonium nitrate residues was determined. Arrangements and heating regimes investigated include low temperature air drying of shallow pools of concentrated plutonium nitrate solutions, evaporation of water from a small vessel containing plutonium nitrate at different vapor rates, and heating solids remaining after evaporation of shallow pools of plutonium nitrate to near dryness. Releases during the air drying of plutonium nitrate solutions, at ambient temperature and with slow heating rates, were small (0.001 wt % maximum) as were releases during the low temperature heating of the solid residues (3×10^{-6} wt % maximum). Forced evaporation of a plutonium nitrate solution released measurable airborne plutonium under all conditions. During full rolling boil 0.18% of the plutonium nitrate was airborne during evaporation of 90% of the liquid in a small beaker. The solids remaining after evaporation of the solution had fractional releases ranging from 0.0046 to 0.012 wt % during a 2-hour sampling period. Air at 400, 700, and 1000°C was used in an upsweep at 10, 50, and 100 cm/sec. One sample was partially converted to oxide and released 0.12 wt % during the 2-hour period. Median Mass Diameter of the particles airborne during this run was 20.5 microns. (auth)

13869 (DP-MS-68-7) WRED: A SITING CODE TO ESTIMATE DOSE PROBABILITY DISTRIBUTION FROM MEASURED METEOROLOGY DATA. Cooper, R. E. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). May 15, 1968. 9p. (CONF-680607-11). Dep. CFSTI.

From 13th Annual Health Physics Society Meeting, Denver, Colo.

A reactor-site evaluation method which determines the frequency of occurrence of various simultaneously occurring atmospheric dispersion conditions and calculates the resulting potential off-site dose following an assumed radioactivity release is described. The computer program WRED uses temperature, wind velocity, and wind direction data to determine dispersion properties, determine whole-body gamma and thyroid inhalation doses, classify each dose according to magnitude, distance, and release height, and provide output suitable for dose vs. frequency of occurrence analysis. (W.H.K.)

13870 (EUR-4088) ENVIRONMENTAL RADIOACTIVITY, ISPRA, 1967. de Bortoli, M.; Gaglione, P. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Sept. 17, 1968. 62p. Dep.

Measurements of environmental radioactivity performed during 1967 by the site survey group of the Protection Service are presented. Data are given on the concentrations of strontium-90, cesium-137 and other radionuclides in fallout, air, soil, waters, herbage, animal bones, and foods. (auth)

13871 (IKF-21) ENERGY DISTRIBUTION AND DOSE RATE OF GAMMA RAYS FROM RADIOACTIVE CLOUDS ON THE EARTH'S SURFACE. Schmidt, Anton (Frankfurt Univ. (West Germany). Institut fuer Kernphysik). Sept. 1968. 64p. (In German). Dep.

Thesis.

Energy spectra of γ-rays from radioactive clouds were determined by Monte Carlo methods and by experiments. The clouds were assumed to be either in an homogeneous and infinitely extended medium or above the air-ground interface. Scattered spectra of point sources as a function of the distance from the source and of the height above the interface are calculated. Spectra from γ-rays of radioactive clouds of various sizes and forms are determined by integration. Dose distributions are obtained by further integration. (auth)

13872 (SWRHL-50-r) NIMBUS-B/SNAP-19 LAUNCH: MAY 18, 1968, OFF-SITE RADIOLOGICAL SURVEILLANCE. (Public Health Service, Las Vegas, Nev. Southwestern Radiological Health Lab. National Center for Radiological Health, Rockville, Md.). Dec. 1968. 37p. Dep. CFSTI.

The off-site area near Vandenburg Air Force Base was monitored during and after the unsuccessful launch of the Nimbus-B/SNAP-19 satellite. A variety of environmental samples was collected from the mainland, sea, and channel islands and was compared to previous data from the area. During the recovery operations, additional samples were taken. No increase in environmental radioactivity levels was observed from this operation. (auth)

13873 (TLW-6030) THE ANALYSIS OF HIGH-ALTITUDE SAMPLES FROM THE SIXTH ANNOUNCED CHINESE NUCLEAR TEST. Progress Report. Holland, Walter D. (Tracerlab/West, Richmond, Calif.). Dec. 3, 1968. Contract AT(04-3)-682. 19p. Dep. CFSTI.

Following the June 16, 1967, Chinese nuclear test, fallout particles were detected in two distinct layers of the stratosphere above the polar region. To determine if there are differences in the particle-size distribution of fallout in these two layers, 5 filters used in late 1967 and early 1968 for sampling the polar stratosphere were examined and the resulting data compared with data from a blank filter not used in the sampling. The blank filter showed numerous spherical particles which could be confused with the Chinese nuclear test debris particles. The gross particle-size distribution in the flown filter samples suggested that the concentration of Chinese nuclear test debris was not significantly greater than the concentration of background particles found on the blank filter. (L.C.L.)

13874 BULLETIN OF THE ATMOSPHERIC RADIOACTIVITY, NO. 50, JULY-SEPTEMBER, 1967. Taiki Hoshano Kansoku Seiseki, No. 50, 1-55(July-Sept. 1967).

Tabulated data are presented on radioactivity measurements made on samples of air, airborne dusts, and rain collected at various Japanese sites during July through September 1967. (L.C.L.)

13875 CONCENTRATION OF ^{32}Si IN THE ATMOSPHERE. Vilenskii, V. D.; Emel'yanov, V. V. At. Energ. (USSR), 25: 444-5(1968). (In Russian).

In order to determine ^{32}Si ($T_{\frac{1}{2}}$ = 500 to 600 years), the ashed sample was fused with caustic in an iron crucible, treated with water, and evaporated with HCl to give a 90% yield of SiO_2. The ^{32}P daughter of ^{32}Si was then recovered after adding phosphorous carrier by precipitation with iron hydroxide or magnesium ammonium phosphate, and extraction of phosphomolybdic acid with 20% butanol in ether. The average chemical yield was 70%. The beta activity was counted on a flow, beta counter. The ^{32}P extraction procedure and counting were repeated in order to improve the reliability of the results. The ^{32}Si content of Moscow air was found to be $3.9 \pm 0.3 \times 10^{-6}$ dist/min m^3 which significantly exceeds the ^{32}Si of cosmogenic origin (4.5×10^{-7} dist/min m^3). These higher ^{32}Si concentrations may be a result of nuclear testing. Measurements of ^{32}Si and ^{90}Sr concentrations in annual layers of glacier deposits would be of great interest. The presence of these amounts of ^{32}Si in the atmosphere may be significant in geophysical and geochemical research. (TTT)

13876 ^{238}Pu IN FALLOUT. Mamuro, T.; Matsunami, T. (Radiation Center of Osaka). Science, 163: 465-7(Jan. 31, 1969).

The observed variation in the activity ratio of plutonium-238 to plutonium-239 plus plutonium-240 in rainwater in Japan over the period from 1961 through 1968 seems to indicate that the influence of the plutonium-238 released by the burnup of the nuclear auxiliary power generator (SNAP-9A) became noticeable within about 6 months and that variation in the isotope ratio with time is affected by nuclear debris produced in the latest explosions as well as by the plutonium-238 released from the SNAP-9A generator. (auth)

13877 SOME PROBLEMS OF NUCLEAR METEOROLOGY FROM THE STANDPOINT OF EVALUATION OF NUCLEAR HAZARDS. Santomauro, L. (Osservatorio Astronomico di Brera, Milan). pp 913-20 of Radiation Protection. Part 2. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968. (In Italian).

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.2).

The selection of a site for a nuclear installation represents one of the most important aspects of nuclear meteorology. After a brief critical review of previous experience, some general criteria regarding the type of nuclear plant are reported. The geometric limits of the atmospheric situation which it is useful to analyze and control either in the construction phase or in the operational phase are discussed in the light of present research on the stratum and substratum limits of the atmosphere. The effective height of the chimney for the release of radioactive gaseous effluents is also discussed. (tr-auth)

13878 ENVIRONMENTAL CONTAMINATION AND RADIATION BURDEN FROM FREE RADIOACTIVE MATERIALS IN THE ATMOSPHERE. Vogt, K. J. Kernforschungsanlage, Juelich, Ger.). pp 921-7 of Radiation Protection. Part 2. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968. (In German).

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.2).

The propagation of radioactive material in the atmosphere was treated according to the theory of turbulent diffusion. With application of the meteorological parameters proposed by Pasquil, the distribution of the activity concentration in the atmosphere, the deposition of the air contaminants on the ground, and the decrease of the activity of air released by fallout, washout, and radioactive decay were calculated, from which the inhalation and ingestion dangers can be derived. Whereas in the emission of radioactive aerosols the incorporation by respiration and absorption of food is the critical type of burden, their external irradiation must be determined in the release of radioactive gases. The radiation burden from β radiation because of its low range can be calculated from the activity concentration at the site of the exposed person. The submersion dose for γ radiation is obtained by integration over the irradiation contribution of the volume elements of the half space. The energy, the half-value time, and the dose constant of the released nuclides as well as the absorption and scattering of the γ radiation in air enter into the calculation in addition to the three-dimensional distribution function. The submersion dose for ^{41}Ar and for fission gas mixtures was calculated. The distribution function of the evaluated magnitudes were graphed in dependence on the source distance in a system of curves and nomograms. The input parameters are the chimney height, diffusion category, wind velocity, and the deposition constants for fallout and washout. The graphic evaluation aids permit in incidents with the release of radioactive materials in the atmosphere a rapid prognosis on the propagation of the released gases and the environmental burden caused. (tr-auth)

13879 EVALUATION OF THE ATMOSPHERIC RADIOACTIVITY IN THE TERRITORY OF CZECHOSLOVAKIA DURING 1967. Petrovic, Pavel. Meteorol. Zpr., 21: 117-22(Oct. 31, 1968). (In Czech).

Data collected during 1967 at the 11 hydrometeorological stations which constantly monitor atmospheric activity are presented. Monthly, weekly, and daily values of radioactive fallout are given. Meteorological analysis of the maximum radioactivity, and the method used for its determination, are described. (JPRS)

13880 STUDY ON THE VARIATION OF TRITIUM AND ^{14}C CONCENTRATIONS IN THE ENVIRONMENT. Kang, Yung-ho (Kyungpook National Univ., Taikyu, Korea). New Phys. (Korea), 8: 1-10(June 1968). (In Korean).

A study was made on the variations of tritium and ^{14}C concentration in the environment employing gas counting and the liquid scintillation counting methods. Through the experiment it was found that: the figure of merit of the new scintillation solvent for the tritium concentration measurement was 193, and the minimum detectable concentration was 152 ± 3.6 T. U. (0.49×10^{-6} μc/ml); α-methyl naphthalene also acted as a toluene-naphthalene solvent; the measured maximum annual mean value of the tritium concentrations in the rainwater in Korea was 1161 T. U. in 1963; the concentrations of ^{14}C in pure liquor, ethanol, and wine, from Korea and those of Japan showed little variation, respectively; the difference in the time variation of the concentration of tritium and ^{14}C in wine seemed to be caused by the difference in the exchange rate of these nuclide in the troposphere; the concentration of tritium in the troposphere decreased exponentially, and its mean-life was about 1.4 years; and the significant variation of ^{14}C with latitude was not observed. (auth)

13881 RELATIONSHIP OF LASTING ARTIFICIAL RADIOACTIVITY OF THE AIR AND PRECIPITATIONS OF THE REGIME OF TEMPERATURE INVERSIONS. Teneva, M.; Manolov, L. Khidrol. Meteorol., 17: No. 1, 35-48(1968). (In Russian).

Temperature inversions exert an influence both on the concentration of artificial radioactivity in the surface air layer and on the content of artificial radioactivity of precipitation. In temperature inversions, the artificial radioactivity of the surface air decreases, while in precipitations from clouds above them it increases. The high inversions exert the greatest influence on the artificial radioactivity of precipitations; there the radioactivity of precipitations is the greatest. In precipitations of different types of clouds, the specific radioactivity of these precipitations is always greater, when temperature inversions are present, than in normal temperature stratification. (Abstr. Bulg. Sci. Lit.)

13882 SOME EXAMPLES AND LIMITATIONS OF THE RADS AND ARADS COMPUTER PROGRAMS. Plato, Phillip A.; Menker, Donald F.; Dauer, Maxwell (Univ. of Miami School of Medicine, Fla.). Health Phys., 16: 383-91(Mar. 1969).

Computer programs dealing with the prediction of the dispersion of airborne radioactive pollutants have been written. Continued use of these programs has shown their flexibility, as well as some of their weaknesses. Examples of both programs are presented. (auth)

Mineralogy and Exploration

13883 (GJO-928-1) REPORT ON RADON AND HELIUM OCCURRENCES IN SOIL GAS. (Colorado School of Mines Research Foundation, Inc., Golden). Dec. 29, 1967. 58p. CFSTI.

Studies were conducted to evaluate a method of exploring for subsurface uranium deposits by measuring the helium and radon content of soil gas. Soil and rock gas samples were collected for He and Rn analysis from shallow holes in areas of known He production in Arizona and New Mexico, and from a uranium producing district in Wyoming. The experimental procedures are described. It was found that the Ra content of soil and rock gas varied significantly in the Gas Hills, Wyoming, uranium producing area and may be of use in uranium exploration. However, the variations of He content and rock gas samples were not significant enough to be useful. Several recommendations are made for determining the effects of geologic conditions, sampling depth, and time on the measurement of He and Ra content in soil gas. (L.C.L.)

13884 (RME-4099(Rev.)) URANIUM DEPOSITS OF MEXICO. Gabelman, J. W.; Krusiewski, S. V. (Division of Raw Materials (AEC), Washington, D. C.). Oct. 1967. 27p. Dep. GPO $0.35.

Visits were made to uranium deposits in Chihuahua, Coahuila, Durango, and Sonora, Mexico, in 1961 and 1963. These visits and information obtained from the Mexican Comisión de Energía Nuclear indicate that uranium is widely distributed in these states and that Mexico has significant uranium resources which would be exploitable at higher prices than prevailed in 1963. The deposits known at that time did not constitute a large uranium reserve under then current economics. Several thousand tons of ore had been produced through late 1963 from limestone replacement deposits in the Sierra de Gomez area of Chihuahua, and additional reserves may be available from that area as well as from the insufficiently explored low-temperature mineralization environments of Coahuila, northern Tamaulipas, and Nueva León. (auth)

13885 AVERAGE AND TYPICAL CHEMICAL COMPOSITION OF CARBONATITES. Gold, D. P. (Pennsylvania State Univ., University Park). pp 83-91 of International Mineralogical Association. Naidu, P. R. J. (ed.). New Delhi, Mineralogical Society of India, 1966.

From International Mineralogical Association, Fourth General Meeting, New Delhi, India. See CONF-641225.

Some 200 odd analyses for major and minor constituents and a lesser number of trace element analyses, representing 55 carbonatite occurrences from 15 countries and 3 continents, are averaged to give "the average chemical composition of carbonatites." A weighted average, designated "the typical composition," is derived by summing the average values of the individual carbonatite occurrences and dividing by the number of occurrences. The "typical" abundance figures, which are probably the more meaningful values, are as follows (in weight per cent); SiO_2, 5.67; CO_2, 32.16; TiO_2, 0.50; Al_2O_3, 1.77; Fe_2O_3, 3.88; FeO, 3.71; MnO, 0.78; MgO, 6.10; CaO, 37.06; BaO, 0.45; SrO, 0.89; Na_2O, 1.09; K_2O, 0.87; P_2O_5, 1.73; F, 0.38; Cl, 0.31; S, 0.18; SO_3, 0.46; Σ rare-earth oxides, 0.59; H_2O+, 1.42; with trace amounts in parts per million as: Sc, 10; Co, 18.8; Ni, 32.4; Cr, 102; V, 105; Mo, 64; W, 5.9; Cu, 88; Pb, 27; Zn, 160; Sn, 2.5; Ga, 2.4; Y, 113.7; Zr, 461; Nb + Ta, 560; Ge, 3.3; Tl, 0; Li, 15; Cs, 0; Rb, 52; Th, 649; U, 57; Be, 5; B, tr; Ag, 3.9; In, 0. These figures indicate a general impoverishment in sialic, and an enrichment in "deep-seated" constituents. The available data on carbon, oxygen, strontium and magnesium isotopic composition of carbonatites and carbonate rocks of sedimentary origin are reviewed, and it is concluded that carbonatites could not be derived from sedimentary carbonate rocks. (auth)

13886 NEWS GIVEN ON THE LOCALIZATION OF TRACE ELEMENTS IN MINERALS AND ROCKS. Goni, J.; Guillemin, C. (Bureau de Recherches Geologiques et Minieres, Paris). pp 203-8 of International Mineralogical Association. Naidu, P. R. J. (ed.). New Delhi, Mineralogical Society of India, 1966. (In French).

From International Mineralogical Association, Fourth General Meeting, New Delhi, India. See CONF-641225.

Results are reported on studies on the distribution of Pb, Zn, and Cu in monzonitic granite, Ce and Gd in a zircon from leptite, etc. It was found that traces of these elements are localized preferentially in the discontinuities of the minerals or their aggregates. These results confirm those of a previous study on the localization of nickel in antigorite, lanthanides in sphere, and various metals (Cu, Cr, V, and W) in biotites. In addition, it was possible to place in evidence a heterogeneity of distribution of certain elements considered as diadochites, even on the scale of

a monocrystal, for example chromium in diopside and titanium in certain titaniferous augites. The leaching with the aid of aqueous organic acid solutions permits the extraction of most of the trace elements contained in calco-alkaline granites without attacking the silicate constituents of the rock. The latter results suggest that elements in traces are retained in the discontinuities by a mechanism put into play by weak binding energies. (tr-auth)

13887 URANIUM EMPLACEMENT AT GARNET RIDGE, ARIZONA. Gavasci, Anna T.; Kerr, Paul F. (Columbia Univ., New York). Econ. Geol., 63: 859-76(Dec. 1968).

The uranium occurrence at Garnet Ridge, Arizona, closely associated with a breccia dike and ejection vents, presents problems of unusual interest. Studies indicate that boulder heaps represent the eroded throats of ejection vents originating deep within the basement. These rise through Precambrian as well as Mesozoic and Paleozoic formations. Associated with the vents are areas of structural collapse, and breccia dikes occur within the structure or nearby. The collapse with a chaotic display of tilted and broken strata, apparently followed the formation of the vents and the intrusion of the breccia dikes. Limited argillic alteration accompanied the emplacement of the copper, vanadium, and uranium minerals, distributed in zonal arrangement around one dike. The breccia dike contains fragments of crystalline and sedimentary rocks, cemented by a highly altered matrix. The uranium-bearing host rock is Navajo Sandstone, a host that elsewhere is ordinarily inhospitable for uranium precipitation. This occurrence, while economically of minor merit, is strongly suggestive of epigenetic origin. Pyrope, with a moderate content of almandite and a smaller amount of both grossularite and andradite, is a prominent constituent of rocks in both the ejected blocks and the breccia dike. The rock types represented by the ejected blocks are predominantly metamorphic schist and gneisses. Gases related to deep-seated igneous activity are believed responsible for the turbulent forces that elevated and rounded the blocks to boulder-like forms. The gaseous activity apparently terminated in hydrothermal conditions. (auth)

13888 PROSPECTING INSTRUMENTS USED IN THE SURVEY OF URANIUM–THORIUM AND BERYLLIUM IN THE ILIMAUSSAQ INTRUSION, SOUTH GREENLAND, IN REPORT OF ACTIVITIES, 1967. Loevborg, Leif; Hansen, John. Groenlands Geol. Unders. Rap., 15: 53-8(1968).

Prospecting instruments used in the survey of uranium–thorium and beryllium in the Ilímaussaq intrusion, South Greenland, are described. Since uranium–thorium and niobium mineralizations are most common in the lujavrites of the Kvanefjeld area, and beryllium and niobium are common on the Taseq slope in the northwestern part of the intrusion, work has been concentrated in these areas. Beryllium minerals are found especially in hydrothermal veins, the most common being chkalovite. Lujavrites show the strongest radioactivity in contact with the roof of the intrusion. Prospecting instruments described are beryllometers, digital Geiger counters, and a gamma spectrometer. (Geophys. Abstr.)

Oceanography

Refer also to abstracts 13669, 13828, and 13911.

13889 (UCRL-50547) OCEANIC ROSSBY WAVES: A NUMERICAL RIGID-LID MODEL. Berdahl, Paul (California Univ., Livermore. Lawrence Radiation Lab.). Nov. 18, 1968. 16p. Dep. CFSTI.

A one-layer, rigid-lid ocean model with constant zonal wind stress was integrated with respect to time using the primitive Navier-Stokes equations. The beta-plane approximation served to model the Coriolis force. Although the flow involved was divergenceless, a stream-function formulation was not used. For this reason, the present model is different from that of Bryan. Because it employs the primitive equations of motion, the present formulation is similar to those of Crowley and Gates, except for the free surfaces present in their models. The gradual onset of computational instability restricts the length of integration to less than 10 days of model time. However, with respect to the Rossby waves, the first 5 days of calculation indicate qualitative differences from the models of Crowley and Gates. Energy transfer due to Rossby waves of long wavelength is radically different in direction. Thus, the rigid-lid approximation fails badly for long wavelength waves. (auth)

Seismology

13890 (NP-17756) PROJECT PRE-GONDOLA II: SURVIVAL OF HYPOTHETICAL PREEMPLACED CHARGES. Miscellaneous Paper N-68-8. Joachim, C. E. (Army Engineer Nuclear Cratering Group, Livermore, Calif. Army Engineer Waterways Experiment Station, Vicksburg, Miss.). Nov. 1968. 25p. Dep. CFSTI.

Stress and particle velocity (horizontal and vertical) data were obtained from a 140-ton nitromethane row-charge detonation in a saturated clay-shale. The charge row consisted of two 40-ton and three 20-ton charges placed in a row with 80 ft between each charge. The charge line ran S 10°W from the center of the existing Pre-GONDOLA I Charlie crater with the first charge 105 ft from the center. Three sand-filled survival holes 80 ft apart were located in line with the charge row at the south end, the first hole being 105 ft from the closest charge. Gages were placed at depths varying from 60 to 70 ft in the survival holes. The unsaturated sand in the survival holes had a much lower impedance (ρc) than the surrounding Bearpaw clay-shale. This impedance mismatch resulted in a reflective interface that greatly reduced the incident stress and motion measured at the survival hole gages. Initial peak horizontal velocity, input from charges H and I (approximately 69 tons), compares well with the 20-ton charge data obtained from Pre-GONDOLA I and the main gage line of Pre-GONDOLA II. The closest survival hole (J) appears to have sustained damage, although additional data would be required to assess the extent. The remaining two survival holes (K and L) appear to have sustained light damage but would be usable. (auth)

13891 SELF-SIMILAR STRONG SHOCKS IN AN EXPONENTIAL MEDIUM. Hayes, Wallace D. (Princeton Univ., N. J. Stanford Research Inst., Calif.). J. Fluid Mech., 32: 305-15 (May 3, 1968).

In connection with the problem of predicting the behavior of strong explosions in the atmosphere, the laws governing the propagation of strong shock waves in media with exponentially varying density are of interest. The self-similar one-dimensional propagation of a strong shock wave in a medium with exponentially varying density and ray-tube area was studied, using the Eulerian approach of Sedov. Conservation integrals analogous to Sedov's are obtained, with the expression for the Lagrangian variable. Calculated results are compared with the predictions of the CCW (Chisnell, Chester and Whitham) approximation. It was found that, in contrast to the implosion case, the propagation parameter from the CCW approximation is in error by 15% or more. (auth)

13892 PROPAGATION UPWARD OF THE SHOCK WAVE FROM A STRONG EXPLOSION IN THE ATMOSPHERE. Hayes, Wallace D. (Princeton Univ., N. J. Stanford Research Inst., Calif.). J. Fluid Mech., 32: 317-31(May 3, 1968).

A method is established for calculation of the trajectories of shocks moving upward in the atmosphere, on the basis of the assumption that they are of the self-propagating type. The results of calculations for self-similar motions are given, and these are used to establish a propagation law based upon the concepts of the Chisnell, Chester and Whitham (CCW) approximation. This propagation law enters a characteristics law based upon that proposed by Whitham, but reformulated for the computation of axisymmetric shocks with varying density. An asymptotic self-preserving shock shape is investigated, and is computed for the case $\gamma = 1.4$. A parabolic approximation scheme suggested by the self-preserving solution is developed, in which the solution near the axis is reduced to the solution of a system of ordinary differential equations. Finally, the governing equation for the general case without axial symmetry (but without winds) is presented. (auth)

ENGINEERING

Nuclear Explosions

Refer also to abstracts 13890–13892 and 13907.

13893 (NCG-TR-5) PROJECT ZULU II: LABORATORY-SCALE ROW-CHARGE CRATERING SERIES. Technical Report No. 5. Novak, Michael A. (Army Engineer Nuclear Cratering Group, Livermore, Calif. California Univ., Livermore. Lawrence Radiation Lab.). Nov. 1968. 126p. Dep. CFSTI.

Sixteen row-charge cratering experiments using 1-pound charges of C-4 in a cratering medium of a carefully controlled, moist, compacted sand were conducted to investigate the formation phenomenology and crater geometry of a single row of explosive charges. The spacing between individual charges within the row, the depth of burst of the charges, and the row-connection designs were varied to evaluate the effect of these parameters on the resulting row crater configuration. Row-charge depths of burst (DOB) varied from 1.75 to 2.50 feet and charge spacings varied from 0.7 to 1.2 R_a. The enhancement of row crater dimensions (width and depth) compared to single-charge craters at equivalent depths of burst decreased as charge spacing increased and as DOB decreased. Single-charge dimensions were approached at spacings greater than 1.2 R_a. At DOB's near optimum (i.e., 1.75 feet), the minimum ratio of lip crest height to apparent crater depth, H_{al}/D_a, was approximately 0.35 and the minimum ratio of width of apparent lip crest to width of apparent crater, W_{al}/W_a, was approximately 1.4. The maximum surface ground zero (SGZ) target velocity varied with DOB according to the relationship, $V_{SGZ} = 310\ (DOB)^{-2.5}$. In general, the crater volume per charge was maximized at a charge spacing of 1.1 R_a. The smoothest row-charge connection was obtained for that experiment in which the ratio of the distance from connecting charge to nearest free surface to the DOB of the connecting charge (NFS/DOB) was approximately 0.80, the most irregular row-charge connection was obtained when this ratio was approximately 0.92. (auth)

13894 (NCG-TR-6) NUCLEAR EXCAVATION DESIGN OF A TRANSISTHMIAN SEA-LEVEL CANAL. Hughes, Bernard C. (Army Engineer Nuclear Cratering Group, Livermore, Calif.). Oct. 1968. 64p. CFSTI.

The feasibility of, and most suitable route for, construction of a sea-level canal connecting the Atlantic and Pacific Oceans by conventional or nuclear excavation methods is investigated. Determining factors of the estimated cost of construction are given. Nuclear methods for construction of a sea-level canal through the Darien region of Panama and the Atrato-Truando region of northwest Columbia are examined. The safety aspects of using nuclear methods to construct a transisthmian sea-level canal to be considered include seismic propagation, airblast acoustical wave phenomena, and radioactivity release. The results of studies indicate that the potentially damaging effect on buildings of the ground motions resulting from seismic propagations from the nuclear detonations will be the major factor in determining the maximum aggregate yield that can be detonated at any one time along the selected alignment. The site data required for a comprehensive nuclear excavation design analysis of a proposed sea-level alignment include information pertaining to site topography, geology, hydrography, hydrology, meteorology, seismic propagation characteristics, bio-environmental conditions, and medico-ecology. These site data are used, together with data pertaining to nuclear explosive characteristics, cratering characteristics of pertinent geologic media, nuclear cratering detonation effects, and channel design criteria, to develop an engineering-safety-cost analysis which is the basis for the nuclear excavation design. (J.C.W.)

13895 (NTS-196) GEOLOGIC EFFECTS OF THE GREELEY EVENT, NEVADA TEST SITE. Dickey, D. D.; Jenkins, E. C.; McKeown, F. A.; Lee, W. H. (Geological Survey, Denver, Colo.). June 21, 1967. 6p. Dep. CFSTI.

The intermediate yield Greeley event, in which a nuclear device was detonated at a depth of 3,990 feet in Pahute Mesa at the Nevada Test Site, caused fracturing in rocks and spalling of rock from cliffs as far as 3.5 and 8 miles, respectively, from the detonation point. (auth)

13896 (SWRHL-6-r) OFF-SITE SURVEILLANCE FOR PROJECT LONGSHOT. Final Report. (Public Health Service, Las Vegas, Nev. Southwestern Radiological Health Lab.). Dec. 1968. 8p. Dep. CFSTI.

The program of radiation monitoring and environmental sampling conducted in conjunction with Project Longshot, an underground nuclear experiment which took place on Amchitka Island in the Aleutian Chain, on October 29, 1965, is described and the results tabulated. It was concluded that all radioactivity was completely contained during Project Longshot, and that the experiment produced no radioactive exposure of any off-site resident. (L.C.L.)

13897 (TID-24360) PRELIMINARY REPORT ON THE GEOLOGIC EFFECTS OF THE FAULTLESS EVENT. Technical Letter: CENTRAL NEVADA-16. McKeown, F. A.; Dickey, D. D.; Ellis, W. L. (Geological Survey, Denver, Colo.). Mar. 25, 1968. 21p. Dep. CFSTI.

The Faultless Event, an intermediate-yield nuclear explosion, produced fractures as much as thousands of feet in length, most of which are along preevent lineaments. Vertical displacements on the fractures are as much as about 15 feet and horizontal displacements are as much as 3 feet. The displacements, particularly vertical offsets on fractures that bound a quasi-sink area around ground zero, may have occurred hours after initial fracturing related to the explosion. The quasi-sink is a graben bounded on the northwest, southeast, and south by faults; the greatest displacement occurred on a fault at the south margin. The northeast margin of the graben appears to be a hinge line zone characterized by many small tension fractures. Preliminary study of data from pre- and postevent surveys indicates that definite strain patterns existed along principal fractures as well as within the quasi-sink. High-speed motion picture photographs taken from a helicopter during the event show clearly the development of two principal fractures about 1.1 second after the explosion. (auth)

13898 (TID-24618) SUMMARY OF GEOLOGIC EFFECTS OF THE BOXCAR EVENT, NEVADA TEST SITE. Technical Letter: SPECIAL STUDIES-65. Dickey, D. D.; McKeown, F. A.; Ellis, W. L. (Geologic Survey, Denver, Colo.). July 9, 1968. 4p. Dep. CFSTI.

A high yield underground nuclear explosion at the U20i site, formed a sink 1,000 feet in diameter above the explosion point. Fractures opened as far as 20,000 feet from the explosion and rock-falls occurred as far as 15 miles. Most fractures were coincidental with north-trending naturally occurring faults. Maximum displacement along a fault was 3 feet vertically with the downthrown side the same as that on the original fault. (auth)

13899 (TID-24642) PRINCIPAL LINEAR FRACTURES RESULTING FROM NUCLEAR EXPLOSIONS IN PAHUTE MESA. Technical Letters: SPECIAL STUDIES-67. Dickey, D. D.; Ellis, W. L. (Geological Survey, Denver, Colo.). July 22, 1968. 5p. Dep. CFSTI.

Long fractures caused by contained underground nuclear explosions on Pahute Mesa coincide with previously mapped geologic structures. The geology and the explosion-produced fractures are shown on the same base map. (auth)

13900 (UCRL-50482) PHENOMENOLOGY AND CONTAINMENT OF UNDERGROUND NUCLEAR EXPLOSIONS. Germain, Lawrence S.; Kahn, J. S. (California Univ., Livermore. Lawrence Radiation Lab.). Nov. 1968. 50p. Dep. CFSTI.

Some aspects of the phenomenology of underground nuclear explosions are presented. The presentation is divided into four general sections. First, the rather extensive history of routine underground explosions is examined. It is noted that a nuclear explosion may be contained by putting it underground. Those few cases where some radioactivity was released are examined. Second, the calculation of early-time phenomenology—the interactions between a nuclear explosion and the media surrounding it during the first few tenths of a second after the explosion are described. An attempt was made to substantiate these calculations by showing how well they agree with actual measurements. Third, a parallel discussion of the calculation of late-time phenomenology and the verification of these calculations by field observations is presented. Fourth the question of how containment is affected by geologic features such as faults and joints is discussed. The early- and late-time phenomena involved in a 10-kt underground nuclear explosion 750 ft below the desert surface in Yucca Flat are discussed. It was concluded that Yucca Fault is more sensitive than the Area 3 Fault, and movement along these faults is not systematic; Yucca Fault motion occurred most often at scaled distances up to 1000 $W^{\frac{1}{3}}$ ft, Area 3 Fault at distances of up to 500 $W^{\frac{1}{3}}$ ft; and Pahute Mesa motion is associated with preexisting structural discontinuities. The general linear alignment of the extensively long cracks indicates motion on faults which may extend to considerable depths. The likelihood of venting on Pahute Mesa faults is probably of the same order of magnitude as venting on the faults in Yucca Flat. (R.C.K.)

13901 (UCRL-50523) EUCLID: A CODE FOR NUCLEAR CONSTRUCTION OF UNIFORM CHANNELS. Myers, Bruce A. (California Univ., Livermore. Lawrence Radiation Lab.). Nov. 15, 1968. 12p. Dep. CFSTI.

A description is provided of the computer code EUCLID, which can be used to perform calculations for nuclear land channeling. This code assumes a parabolic cross section for the channel. Various parameters are presented which are necessary for the construction of a desired usable channel through either level or sloping terrain. The flow chart for the code and a data sheet are included. (auth)

13902 NUCLEAR ARMS RACE: PROBLEMS OF VERTICAL PROLIFERATION. Kemp, Geoffrey. Technol. Rev., 70: 28-33 (July-Aug. 1968).

In March, 1968, the Soviet Union and the U. S. presented identical draft treaties which were acceptable to the Eighteen Nations Disarmament Conference. The long-term success of this treaty or any other is ultimately dependent upon eventual agreement between the existing nuclear powers to control and curb their own nuclear arms race which continues to spiral upwards. Two factors seem likely to work against an agreement on U. S.-Soviet vertical nuclear arms control. One is the recent technical progress in ballistic missile defense systems and offensive missile delivery systems. The second is the political atmosphere in the United States, which seems likely to become increasingly hostile to any attempt to check the projected growth rate of the U. S. strategic arsenals. Arguments presented refer to developments in the United States rather than the Soviet Union because information on U. S. policy is easier to come by. The Sentinel system, designed to be effective against an irrational Chinese nuclear attack against the U. S. in the 1970's is described. At approximately the same time that the development in ballistic missile defense technology occurred, similar breakthrough in offensive missile design occurred: the development of missiles designed to carry multiple warheads. At present the U. S. has 1054 missile launchers in hardened silos located in the U. S., and 656 in Polaris submarines; in 1967 the Soviet Union had approximately 750 (720 land-based, 30 sea-based). The number of separately targetable warheads could rise from 1700 to anything between 5000 and 16,000. It is highly unlikely that the number of Soviet launchers could rise to more than 2000 in this period. (BBB)

Facilities and Equipment

Refer also to abstracts 14220 and 14735.

13903 (ANL-7488) FORCE-REFLECTING SERVOMECHANISMS WITH SIGNAL-TRANSMISSION TIME DELAY. Thompson, William M. (Argonne National Lab., Ill.). Sept. 1968. Contract W-31-109-eng-38. 114p. Dep. CFSTI.

Thesis. Submitted to Illinois Inst. of Tech., Chicago.

The absolute and relative stability of a force-reflecting servomechanism with time delay in the signal-transmission channels was investigated by several methods. One method used a stability criterion for time-lag systems due to Pontryagin. This criterion is adapted and extended for use in this study. The servomechanism provides the connecting links currently used, electrically connected, master-slave manipulators. The time delay is due to the time required for signals to traverse the distance between the master and slave arms, if they are separated by large distances. Two time delays of approximately 4 and 23 msec are used to illustrate the Pontryagin method. The latter delay corresponds to a separation distance of about 4000 miles. The analog-computer simulation of the system indicated that the stability is very sensitive to the values of gain in the signal-transmission channels. One objective was to determine the stable regions in gain-parameter space. Some stability information was developed by using conventional techniques. The desired information cannot be obtained conveniently by any of these methods because of the number of parameters involved and the complexity of the system. The stability information was obtained by using the Pontryagin criterion. The characteristic equation of this system can be put into the form of an exponential polynomial. The criterion involves investigating the zeros of the real and imaginary parts of the exponential polynomial evaluated along the imaginary axis. These zeros must be real, simple, and alternating. A new method of application of the criterion had to be developed. All earlier applications involved system equations of lower order for which simple trigonometric relations could be derived. This system is fourth order, and no such simple relations exist. The method uses the convenience of digital computation and a simple graphical procedure to check the zeros. A procedure is also given for easily changing the location of the zeros of the real and imaginary parts by adjusting the parameters so that the limits of stability in gain-parameter space can be found. The criterion is based on a fundamental theorem of complex variable theory, Cauchy's principle of the argument, and is explained in those terms to give information on relative stability. Zeros can be excluded from certain regions in the left half plane near the imaginary axis. Examples of the procedures are given, and regions of stability and relative stability were determined in gain-parameter space. Results were verified by analog-computer tests and by direct calculation of the zeros. Results show that there is some slight improvement in relative stability for delays up to about 4 msec. For the delay of 23 msec, however, the desired relative stability cannot be achieved for any reasonable values of gain. The new procedures to determine effects of loads on the system and to solve some classical problems of a more complicated form are discussed. (auth)

13904 (DPSPU-68-30-5) DESIGN AND OPERATION OF A LARGE SAND BED FOR AIR FILTRATION. Sykes, G. H.; Harper, J. A. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Plant). July 1968. Contract AT(07-2)-1. 8p. (CONF-680811-13). Dep. CFSTI.

From Symposium on Operating and Developmental Experience in the Treatment of Airborne Radioactive Wastes, New York.

The design and operation of large sand filters at the Savannah River plant are discussed. These filters, 100 ft wide, 240 ft long, and 8 ft deep, are used in the exhaust air system of the chemical separation facilities. The filters have satisfactorily filtered exhaust air for 13 years. Filtering efficiency has remained greater than 99% with acceptable increases in differential pressure. Activity has penetrated only to the smallest mesh (30 to 50) sand; about 1000 Ci of gamma activity is established to be in the bed. Filtering efficiency has gradually improved probably because dust accumulation has created a finer filter medium. Air flow has ranged from 100,000 to 130,000 cubic feet per minute throughout the years of operation. Filter differential pressures have increased slightly because of dust accumulation and occasionally because of water inleakage. (R.C.K.)

13905 (HW-81386) PROCESS PUMP FAILURES AT THE REDOX FACILITY. Stell, Edward F. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Mar. 18, 1964. 35p. Dep. CFSTI.

The high rate of pump failure at the Redox Facility was studied to determine the causes which directly affect pump reliability. It was concluded that: corrective action is urgently needed to improve pump reliability; a simplified pump design should be substituted for the complex and easily damaged multiple-stage vertical turbine pump now in use; and abrasive solids in the process solutions are a prime factor in reducing process pump life in the first stream cycle. It is recommended that the solids entrained in the process fluids be identified and eliminated (possibly by filtration), that design modifications be made in existing pumps, and that a single-stage pump be developed which does not operate with close fitting, process fluid lubricated bearings. (L.C.L.)

13906 (NRL-6765) HOT CELL EQUIPMENT DEVELOPED FOR REMOTE TENSION TEST SPECIMEN EVALUATIONS AT NRL. Hawthorne, J. R.; Watson, H. E. (Naval Research Lab., Washington, D. C.). June 24, 1968. 22p.

Hot cell equipment and experimental methods for ambient temperature testing of highly radioactive tension specimens are described. Auxiliary equipment developed to aid remote testing includes devices for the following operations: attachment of the specimen extensometer, post-test measurements of the specimen diameter for determining the percent reduction of area and uniform strain, and the measurement of gage length elongation. Special data acquisition capabilities of the system include data generation for the experimental development of true stress-natural strain plots. The device for the continuous sensing of minimum specimen diameter and the system for autographic recording of instantaneous load-minimum diameter from test initiation to specimen failure are described in detail. Present test capabilities were developed primarily for evaluating 0.252-in. and 0.180-in. gage diameter, 1-in.-gage length tensile specimens; however, the extension of this capability to include specimens of different diameters or gage lengths can be readily achieved with only minor modifications to the test equipment and the supporting fixtures. Operations conducted over a two-year period have shown the equipment to be highly reliable and to require only a minimum of routine maintenance. (auth)

13907 (NVO-193-4) DEVELOPMENT OF PROCEDURES FOR PLACING PLASTIC CONCRETE. Interim Report. Tuck, R. L.; Michie, J. D. (Southwest Research Inst., San Antonio, Tex.). Oct. 18, 1967. Contract AT(26-1)-193. 83p. Dep. CFSTI.

An experimental program, conducted to develop procedures for placing a high strength plastic concrete as a structural liner for an underground nuclear emplacement room, is described. The

primary objective was to develop techniques whereby shrinkage and thermal contraction cracking would be minimized or eliminated. A secondary objective was to evaluate plastic concrete mixing and handling equipment. A total of 19 cubic yards of plastic concrete were placed within a two-day test in a simulated emplacement room form. Concrete temperature and strain data were acquired. Subjective observation of equipment performance was made. (auth)

13908 (ORNL-TM-2024) DESIGN COMPARISON OF CESIUM AND POTASSIUM VAPOR TURBINE-GENERATOR UNITS FOR SPACE POWER PLANTS. Fraas, A. P.; Burton, D. W.; LaVerne, M. E.; Wilson, L. V. (Oak Ridge National Lab., Tenn.). Feb. 1969. Contract W-7405-eng-26. 166p. Dep. CFSTI.

The first phase of the study comparing cesium and potassium as working fluids for 300 kW electrical output power plants was concerned with a review of the literature and operating experience both with all sorts of small turbines and with rotating machinery in high temperature systems. From this review a basic set of design precepts was developed to provide a self-consistent set of bases for the study. The next phase of the work entailed a parametric study to determine the effects on turbine efficiency, size, and other key parameters of variations in the number of stages, the rpm, the turbine inlet and exhaust temperatures, and effects of various losses such as aerodynamic, seal leakage, moisture churning, and bleed-off for regenerative feed heating. On the basis of this work a two-stage and a three-stage cesium turbine and a five-stage and an eight-stage potassium turbine were chosen as reference designs for detailed analytical and layout studies. Layouts were prepared and analyses made of the major problems including creep stresses in the turbine rotors, temperature distribution and thermal stresses in the turbine rotors, the dynamics of the bearings and rotors, and moisture formation, deposition, and possible turbine bucket erosion. The results indicate that the two working fluids yield essentially the same overall thermal efficiency, but that cesium gives a lighter and simpler turbine-generator unit. (auth)

13909 (ORNL-TM-2363) DESIGN OF A CAPSULE FOR IRRADIATION TESTING OF URANIUM NITRIDE FUEL. DeCarlo, V. A.; McQuilkin, F. R.; Senn, R. L.; Thoms, K. R.; Weaver, S. C. (Oak Ridge National Lab., Tenn.). Feb. 1969. Contract W-7405-eng-26. 30p. Dep. CFSTI.

The design of an experimental capsule assembly for use in assessing the irradiation performance of uranium nitride (UN) fuel is described. Design conditions for the first irradiation test include operation of the fuel cladding at 1370°C with a linear heat rating of 8.5 kW/ft. A Zircaloy-2 calorimeter provides continuous monitoring of the heat generation rate in the fuel pins. The first test (capsule 05-11) is being conducted in the 05 poolside position of the Oak Ridge Research Reactor to an approximate burnup of 3 at.% U. The irradiation assembly is described, and some initial operating experience is included. Certain revisions were made to the original design due to difficulties experienced with six of the high temperature thermocouples at the outset of neutron exposure. The nature of this problem and the design revisions to alleviate it are discussed. (auth)

13910 (TID-24927) CONCEPTUAL DESIGN STUDY OF A 250-MILLION GALLONS PER DAY COMBINED VERTICAL TUBE-FLASH EVAPORATOR DESALINATION PLANT. Research and Development Progress Report No. 391. (Office of Saline Water, Washington, D. C. Oak Ridge National Lab., Tenn.). Aug. 1968. 191p. GPO $3.50.

A desalting plant combining a multistage flash (MSF) feed heater with vertical evaporator effects in which tubes with fluted surfaces are used to obtain heat transfer performances significantly higher than those usually obtained with smooth tubes is described. The 250-Mgd plant is contained in two trapezoidal reinforced concrete structures, each housing two independent trains. The 15 vertical-tube effects are located above the 50 MSF stages. The vertical tubes condense 83% of the product water for the total plant output; the horizontal feed-heater–condenser tubes condense the other 17%. The overall plant performance ratio is 13 lb of product water per 1000 Btu of heat. The conceptual design utilizes cost and experimental information from investigations by other contractors plus additional information developed by ORNL. The estimated capital cost for a combined flash–vertical-evaporator desalting plant is 30¢ per daily gallon of capacity, and the estimated product cost is 12.9¢ per 1000 gal for the ground rules of the study. These costs are on a 1965 basis and apply to a follow-on plant; that is, it is assumed that a prototype plant incorporating the same technology and fabrication procedures had been built earlier. A cost review of the design by Bechtel Corporation, for a prototype plant and in 1967 dollars, indicated a capital cost of 38.3¢ per daily gallon of capacity. (auth)

13911 LABORATORY FOR THE STUDY OF THE RADIOACTIVE CONTAMINATION OF THE SEA. Com. Naz. Energ. Nucl., Notiz., 14: No. 11, 72-87(Nov. 1968). (In Italian).

A laboratory is described which was established in 1958 at Fiasherino, Italy for studying the radioactive contamination of the sea. It operates on both a national and an international scale through cooperative arrangements and research contracts. Its activities are carried out by the following research teams: physics, chemistry, biochemistry, botanics, zooplanton, microbiology, fishing biology, special developments, and the Oadlisca Laboratory Ship. (auth)

13912 IMPROVEMENTS IN OR RELATING TO AXIAL-FLOW BLOWERS. (to Compagnie Electro-Mechanique). British Patent 1,136,936. Dec. 18, 1968. Priority date Apr. 22, 1965, France.

An axial blower with increased capacity for incorporation in a fluid-tight enclosure such as a gas cooled reactor is described. The blower includes at least two bladed impellers mounted on a common impeller shaft. The shaft is mounted in a pair of bearings. The fluid in the bearings is the same fluid as the fluid blown by the impellers. The impeller shaft is connected to a transmission shaft which is fitted through the wall of the enclosure. The shaft is driven by a motor outside the enclosure. (F.S.)

13913 EXPERIENCE WITH DESIGN AND MANUFACTURE OF PROCESS IRRADIATORS AND THEIR ^{60}Co SOURCES. Brown, M. G. (Atomic Energy of Canada Ltd., Ottawa). Radioisotopes (Tokyo), 18: 26-31(Jan. 1969).

High, intermediate and low capacity irradiation plants for the sterilization of medical products are discussed. The plants consist of a ^{60}Co source, source storage, mechanism for transferring the source from the storage pool to the irradiating position, an irradiation cell and a product conveyor system. Annual unit processing costs are given. Food irradiation plants and ^{60}Co sources and their encapsulation are also described. (F.S.)

13914 HOIST MECHANISMS. Shaw, Michael Kevin; Richards, George William (to English Electric Co., Ltd.). British Patent 1,141,609. Jan. 29, 1969. Filed July 30, 1965.

A hoist mechanism is described which includes flexible load-bearing suspension means for a body to be raised or lowered. The body should have at least one flexible member comprising a pipe or electric lead therefrom. The suspension means and the flexible member(s) (one end of each being anchored to a fixed point) are arranged to pass together around a rotatable guide which moves vertically. The suspension means is furnished with a plurality of channel-like guides projecting therefrom at intervals by substantially more than the thickness of the flexible member(s) so that the latter pass through the guides and can assume a radius substantially greater than that assumed by the suspension means. Preferably the suspension means comprises a chain and the guide a sprocket engaging the chain. The hoist mechanism is arranged for lowering and raising a body (such as a neutron flux detector into and out of a reactor core with the mechanism and rotatable guide being in a standpipe plug of the reactor. (UK)

13915 IMPROVEMENTS IN OR RELATING TO INTERNAL BORE WELDING. Roper, Roland Maitland; Sherwood, Eric Arthur; White, William Rogers (to United Kingdom Atomic Energy Authority). British Patent 1,141,970. Feb. 5, 1969. Filed May 12, 1966.

The technique described is for application to tube bores and particularly in the welding of tubes to tube plates in the manufacture of heat exchangers. It consists of rotating around the joint to be welded, a welding arc struck between the bore wall and an electrode inserted into the bore on the end of a spindle or similar electrode carrier, of slender dimensions. The apparatus includes a stationary sleeve guide having a tapered peripheral surface, with a bore through which the electrode or its holder extends, the peripheral surface being adapted to engage the rim of this bore in order to centralize the axis of the sleeve guide with that of the bore. The electrode is shrouded by an outer concentric insulating tube which extends into the bore to be welded, and has enlarged diameter section adjacent to the joint to be welded in order to define a minimum clearance between the electrode tip and the bore wall. Means are provided for mounting the sleeve guide in a support member, with suitable retraction mechanism. A suitable torch and drive mechanism are also described, together with the method of operation of the apparatus. (UK)

13916 HEAT EXCHANGE APPARATUS. Clarke, Peter Joseph (to Joseph Lucas (Industries Ltd.)). British Patent 1,137,251. Dec. 18, 1968. Filed Nov. 30, 1964.

In heat exchange apparatus where a plurality of longitudinally extending heat exchange elements are arranged in parallel re-

lationship in a pack, the elements being carried by spaced support structures, there is a tendency for a temperature gradient to occur through the pack between the elements on one side of the assembly and those on the opposite side. To overcome this it is proposed that guide vanes should be disposed symmetrically about the central axis around which the elements are arranged, the guide vanes extending between and being connected to adjacent support structures and being tilted with respect to the axis so as to cause the heat exchange medium to follow a generally helical path about the axis. An example is given relating to fuel rods for use in a liquid metal cooled fast reactor. (UK)

13917 STRESSES IN SHELLS OF REVOLUTION. Tsui, Edward Y. W. Menlo Park, Calif., Pacific Coast Publishers, 1968. 295p. $12.50.

The linear theory and its practical application to shell structures having the form of surfaces of revalution are presented. Applicable stresses in missiles, spacecraft, pressure vessels, conventional and nuclear reactors, and similar thin shells are studied. (J.C.W.)

13918 METHOD FOR INCREASING HEAT FLUXES IN A BOILING-LIQUID COOLED REACTOR. Torikai, Kinichi (to Japan Atomic Energy Research Inst.). Japanese Patent 1968-23115. Oct. 4, 1968. Filed Feb. 9, 1966.

By the method proposed, in a boiling-liquid cooled reactor the burn-out heat fluxes can be increased, to increase in turn the reactor heat fluxes; the result is an increase in the output of the reactor. A circular plate with orifices through it is placed within the cooling liquid in the reactor, over the outlets of cooling channels in the reactor core, in order to increase the flow resistance of cooling fluid. A method is described to increase the reactor heat flux in a boiling-liquid cooled reactor by increasing burnout heat fluxes. A circular plate with orifices in it is placed in the cooling liquid over the outlets of the cooling channels in the reactor core to increase the flow resistance of the cooling fluid. (NSA of Japan)

13919 DEVICE FOR IRRADIATING IN A REACTOR WITH A HYDRAULIC RABBIT. Ouchi, Shinpei (to Japan Atomic Energy Research Inst.). Japanese Patent 1968-23118. Oct. 4, 1968. Filed Mar. 30, 1965.

A device is described for cooling sample material in a hydraulic rabbit device during sample removal. Cooling liquid is introduced by a separate path to counteract the change in the direction of flow of the hydraulic fluid. (NSA of Japan)

13920 IRRADIATION DEVICE. Ishii, Sueji (to Hitachi Ltd.). Japanese Patent 1968-22798. Sept. 25, 1968. Filed Sept. 9, 1966.

A device is described for the uniform irradiation of encapsulated samples. The finned capsule is placed close to a radiation source within a pneumatic tube cooled by a gas. A support for the capsule is installed in the tube with a bearing for sample rotation. The capsule in the support is rotated by a cooling gas flowing by the side of fins. (NSA of Japan)

13921 SHEET-SWITCH DEVICE FOR A REACTOR. Nakamura, Hideo (to Hitachi Ltd.). Japanese Patent 1968-23113. Oct. 4, 1968. Filed July 6, 1965.

In some types of nuclear reactors, a control rod is moved up and down through the reactor core by a member connected below the rod and a driving shaft below the member. At the time of a scram, the control rod is dropped into the core over the full height of the core. A device is described that determines the position of the member at the end of the scram. The device consists of using a magnetic material member; magnets, installed on the outside of the cylinder at the scram position of the member; and a lead switch located next to the magnets which closes or opens depending on the magnetism. When the member has dropped and is in the scram position a magnetic circuit, sufficient to operate the lead switch, is formed. (NSA of Japan)

13922 LID WITH A RADIATION SHIELD FOR A REACTOR PRESSURE VESSEL. Sugino, Shigemi (to Hitachi Ltd.). Japanese Patent 1968-22787. Sept. 25, 1968. Filed Feb. 2, 1966.

A reactor pressure vessel lid is described which has the following advantages: shielding at the top of the reactor pressure vessel and prevention of radiation heating and damage. The inside of the pressure vessel lid in the form of an inverted pan is partitioned into several horizontal spaces by the use of curved plates, each plate has a central vent hole. A tube runs into the bottom space from outside the pressure vessel and another tube runs from the top space to the reactor core, through the interior of the pressure vessel. Shielding water, entering along the first tube, circulates through the bottom space, upper spaces and the top space, and finally towards the reactor core through the second tube. (NSA of Japan)

13923 FUEL EXCHANGE DEVICE. Sasaki, Masayoshi (to Hitachi Ltd.). Japanese Patent 1968-23109. Oct. 4, 1968. Filed Feb. 27, 1964.

A fuel loading device is proposed for use at a reactor which has pressure tubes immersed in heavy water penetrating through the reactor core. Each pressure tube contains the fuel element, shielding, orifice and sealing plugs with the coolant entering the tube at one end and leaving at the other end. Grabbing equipment is placed to grab the fuel element to be replaced, and a cylinder is provided for the tube. Another fuel element is then installed. (NSA of Japan)

13924 POSITIONING DEVICE. Kato, Azuma (to Fuji Electric Mfg. Co., Ltd.). Japanese Patent 1968-22975. Sept. 28, 1968. Filed Nov. 17, 1965.

A device is described for remotely placing and securing a table with a measuring instrument at a certain position at an experimental critical assembly. A cam groove for positioning, with a guide slope surface, is located at the position which receives the approaching table. The table is positioned roughly by the first positioning mechanism leaving some space for further movement. After completion of this positioning a pushing rod on the table, capable of movement in a direction at right angles to the movement of the table, is actuated. The pushing rod engages the cam groove, along the guide surface, in order to obtain the accurate positioning and to tightly secure the table. (NSA of Japan)

13925 DEVICE FOR PRODUCING NEGATIVE IONS IN AN AIR PURIFIER. Asahina, Jiro. Japanese Patent 1968-22272. Sept. 24, 1968. Filed Nov. 29, 1963.

A device is described for producing negative ions while air is purified. The apparatus is compact and easy to install. Air is drawn in and after being purified, blown by electric fans. Close to the fan solid material, obtained by solidifying powders of Ra, Th, etc., in a resin is placed in order to ionize the incoming air. To further increase the amount of negative ions, the unit is grounded. (NSA of Japan)

13926 COMPARISON OF PERFORMANCE CHARACTERISTICS OF SOME FILTERS USING THORON DAUGHTERS AS RADIOACTIVE AEROSOL. Yoshida, Yoshikazu (Japan Atomic Energy Research Inst., Tokai); Kitano, Kyoshiro; Murata, Mikio; Moriyasu, Seizaburo. pp 1561-7 of Radiation Protection. Part 2. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

The important characteristics of air sampling filters are collection efficiency, flow resistance and surface collection efficiency. A comparison was made for these performance characteristics between the filters used at present in JAERI for air sampling and those (made in trial) by a Japanese manufacturer. Collection efficiency, and also alpha energy resolution were tested using the Millipore AA filter as a reference filter and thoron decay daughters as a test aerosol; the significant particles were less than 0.1 micron in diameter. The cellulose filters tested, showed nearly the same performance characteristics as Whatman 41, and the collection efficiencies of this type of filters was over 90% at face velocities larger than 64 meters per minute. The cellulose asbestos filters tested for alpha air sampling proved superior to HV-70. This filter has a collection efficiency greater than 99.5%, and about the same surface collection efficiency as the glass fiber filter Gelman E, generally used for alpha air sampling. On the basis of these tests, it was decided to use the cellulose asbestos filter for alpha air sampling in JAERI. (auth)

13927 ON-SITE TESTING OF FILTERS WITH SPECIAL REFERENCE TO SOLID AEROSOLS. Flyger, Hans; Rosenbaum, H. C. (Danish Atomic Energy Commission, Risoe). pp 1551-9 of Radiation Protection. Part 2. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

A lithium flame photometer test is proposed for on-site testing of filter installations. The lithium test is intercalibrated with the standard Sodium Flame Test. The spraying time needed to introduce the lithium salt into a ventilation system is considered inconvenient for systems handling more than 10^5 m^3/hr. For such systems photoelectric particle counters can be used with the dust naturally present in the local atmosphere. Where the dust level is too low, Aitken nuclei can easily be artificially generated in sufficient amounts. The relation between filter evaluation by such particle counting and by lithium measurements is established. (auth)

13928 PROBLEMATICAL POINTS IN MAINTENANCE OF LONG INTAKE STEEL PIPE BURIED UNDER THE SEA BOTTOM. EXISTING STATE OF THE INTAKE STEEL PIPE FOR COOLING

THE CONDENSER OF TOKAI ELECTRIC POWER PLANT. Tsujimoto, Susumu (Japan Atomic Power Co., Tokyo); Watanabe, Yoshio. Doboku Gakkaishi, 53: 41-8(Oct. 1968). (In Japanese).

The Tokai Atomic Power Station, which started its 166,000 kW full power operation in July 1967, has operated satisfactorily for a year with few difficulties. In the power station, two steel pipes, 2.5 m in diameter and 500 m long, extending into seawater through the sediment are used for cooling the steam condensers by taking in 16 m^3/sec. seawater. The situation there is formidable, because of the rough waves in the Pacific Ocean. Problems in the maintenance of the intake steel pipes are described including an outline of the cooling facilities for the steam condensers, and, maintenance of the steel pipes and intakes such as, for example, inflow of mud and sand into the pipes and manholes; adhesion of marine life on the inside surface of the pipes; stability and corrosion of the pipes. (NSA of Japan)

13929 EQUIPMENT OF TSURUGA POWER STATION, JAPAN ATOMIC POWER CO. Obayashi, Teizo (Tokyo Shibaura Electric Co., Ltd.); Ando, Hirshi. Toshiba Rebyu, 24: 4-12(Jan. 1969). (In Japanese).

The construction of the Tsuruga Power Station, Unit No. 2, Japan Atomic Power Co., is now under way, and operation is expected to begin in December of next year. The unit is the first boiling water reactor plant in Japan. The contractor for the supply of equipment is the General Electric Company. Toshiba is the major subcontractor for supplying the primary containment vessel, installing the reactor recirculation system, the control-rod-drive feed-water system, the turbine-generator and other electric equipment. The equipment, and various problems encountered in regard to the design, manufacture and installation of the equipment are described. (NSA of Japan)

13930 SEISMOLOGICAL DESIGN OF BWR PLANTS. Ichiki, Tadaharu; Kitagawa, Koji (Tokyo Shibaura Electric Co., Ltd.). Toshiba Rebyu, 24: 44-6(Jan. 1969). (In Japanese).

Radioactive materials should not be released in case of any accident in atomic power plants. In particular, during earthquakes which have an enormous amount of energy, special consideration should be given to make the plant construction sufficiently resistive. A recent trend of atomic power plant design is that dynamic analysis is carried out by introducing dynamic consideration into conventional static design. This article is a description of methods of the quake-proof design and the dynamic analysis for boiling water reactors. (NSA of Japan)

13931 PERFORMANCE TEST OF JET PUMPS FOR BWR. Masuda, Takahisa; Fujisaki, Yukio (Tokyo Shibaura Electric Co., Ltd.). Toshiba Rebyu, 24: 47-52(Jan. 1969). (In Japanese).

Latest BWR plants are provided with jet pumps in pressure vessels in order to reduce the number of outer recirculation loops. A series of experiments were carried out under high pressure and different temperatures up to 280°C using one-third-sized models of three kinds of actual jet pumps. The results show that temperature has little effect on efficiency and that performance is unaffected by driving flow rate. The experimental data have proved theoretical calculation useful for design. (NSA of Japan)

13932 SWAGING TODAY. Strohecker, Daniel E. (Battelle Memorial Inst., Columbus, Ohio). Tool Mfg. Eng., 60: No. 5, 36-40(May 1968).

Advances in equipment have extended the field of application of swaging to nonconcentric shapes and to joining and fastening operations. The materials which can be swaged and the operating conditions for swaging specific materials are described. The swaging process, in general, and its capabilities are discussed as well as die and mandrel design, materials, wear, the use of lubricants on the sliding surfaces of the swaging machine and of coolants during hot swaging, and the effects of swaging on the properties of materials. Illustrations are presented of a number of examples of variously shaped swaged parts. (L.C.L.)

13933 USE OF ATOMIC ENERGY FOR DESALTING SEA WATER BY THE HYDRATE PROCESS. Martynovskii, V. S.; Smirnov, L. F. (Odessa Technological Inst. of the Food and Refrigeration Industry). Izv. Vyssh. Ucheb. Zaved, Energ., No. 5, 70-6(1967). (In Russian).

Various methods for desalination of sea water are analyzed and it is shown that the thermodynamic efficiency of the distillation process is about 7% while that of the contact freezing process with isobutane is no better than 14%. The hydrate process with contact heat exchange reduces energy consumption and raises the thermodynamic efficiency of the desalting cycle to 20 to 24%. In addition to increased efficiency, hydrate installations are comparatively inexpensive and present no problems with respect to corrosion and accumulation of deposits. Practical solutions may be found for the problem of separating the crystals from the brine. The installation may be powered by heat instead of electricity by using a turbine and turbocompressor mounted on a single shaft, thus obviating the necessity for intermediate generation of electric power with consequent outlay for equipment and additional power losses. Three systems are proposed which utilize the steam from an atomic reactor for simultaneously producing electric power and fresh water by the hydrate method. In the first system, the steam from the reactor is sent through a single-circuit uniflow channel to the generator turbine and from there to the desalting turbine. The second type of installation is an indirect-flow system in which the desalting turbocompressor may be driven from a turbine operating on a refrigerant. Schematic diagrams of these two systems are given and the operating principles are described. Brief consideration is also given to a system which uses a steam turbine and a refrigerant turbocompressor with an atomic reactor connected in a conventional two-circuit heat transfer installation. It is shown that the energy from 1 kg of steam in this type of setup may produce as much as 26 kg of fresh water. (ATD)

13934 CONTINUOUS MEASUREMENT OF WEAR OF FURNACE LININGS WITH RADIOACTIVE ISOTOPES. Bergh, Sten; Sandberg, Hans; Stahl, Nils (Domnarvets Jernverk, Borlaenge, Sweden). Jernkontorets Ann., 152: 447-50(1968). (In Swedish).

A method is described to study the wear of steel-furnace linings. Neutron-irradiated iridium (Pt-10 percent Ir) wires were inserted in discrete levels of the lining. The activity of the steel phase of the melt was then measured. (Sweden)

13935 MATERIALS PROBLEMS IN DESALINATION. Gillam, W. S. (Dept. of the Interior, Washington, D. C.). Ocean Eng., 1: 137-42(Dec. 1968).

A brief description is given of the materials problems associated with water desalination technology with emphasis on the corrosion of materials in saline water and on the need for the most economical use of conventional and new or improved materials. (L.C.L.)

13936 IMPROVEMENTS IN OR RELATING TO FLEXIBLE CLOSURE MEMBERS. (to Philips Electronic and Associated Industries Ltd.). British Patent 1,142,648. Feb. 12, 1969. Priority date Mar. 18, 1965, France.

A flexible member is described for use in closing apertures in, for example, a chamber where articles are to be handled in a controlled atmosphere. The member allows the insertion of the bare hand to handle the articles in the chamber. It consists of a sleeve of flexible material (rubber) constructed at one end for connection to the periphery of the aperture and formed with creases such that the sleeve can be folded from an open condition to a condition in which the opening through the interior of the sleeve is closed. (UK)

Heat Transfer and Fluid Flow

Refer also to abstracts 13916, 13918, 14385, 15629, 15634, 15635, 15653, 15675, and 15694.

13937 (AEEW-M-792) DYNAMICS OF SODIUM VAPOUR BUBBLES. Judd, A. M. (Atomic Energy Establishment, Winfrith (England)). Apr. 1966. 27p. (FRPC/RSWP/P-(66)107). Dep. CFSTI. UK.

A method of calculating the expansion of vapor bubbles in superheated liquids which is valid when applied to sodium is described. The rate of expansion of a bubble and the severity of the accompanying pressure pulse are calculated for various superheats up to 400°C. The method is also applied to the collapse of bubbles in subcooled liquid, and the time taken for bubbles to collapse and the frequency of oscillations of the bubble radius are found. Errors due to various approximations in the method are analyzed and suggestions for improvements are made. (auth)

13938 (EUR-3935) MEASUREMENT OF THE VOID FRACTION IN A TWO-PHASE NaK-ARGON FLOW BY GAMMA-RAY ATTENUATION. Milliot, B.; Lazarus, J.; Navarre, J.-Ph. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Mar. 28, 1968. 54p. (In French). Dep.

For determining the void fraction in a two-phase flow artificially created by injecting argon in a flow of NaK, the γ-attenuation method was used. This measuring method has been applied simultaneously with other methods already described in the report EUR-3486 f (1967). The results obtained in 1966 are confirmed by the new set of tests. Reproductibility is satisfying. The γ-attenuation method gives good experimental results. But their interpretation does not permit the γ-attenuation method to

be considered as a simple measuring method for void fraction. (auth)

13939 (GAMD-8842) SYNTHESIS METHODS IN HEAT CONDUCTION. Del Bene, J. V. (Gulf General Atomic, Inc., San Diego, Calif.). Jan. 20, 1969. Contract AT(04-3)-167. 54p. Dep. CFSTI.

The results of a study on the application of synthesis methods in heat conduction are presented. The synthesis technique, which is a form of the integral methods used to obtain approximate solutions to differential equations, was developed with the objective of reducing computer time for calculating three-dimensional neutron flux distributions in reactor cores. To evaluate the potential use of the synthesis method in the area of heat conduction, the method was applied to a simple steady-state heat transfer problem and a simple transient problem. The numerical results for these specific problems are presented and compared with finite difference solutions. It appears that the synthesis technique is not superior to a finite difference calculation for all types of problems. However, it may offer advantages for certain specific problems, for example, the extrapolation of transients. To obtain a better evaluation of the method requires the use of larger expansions in the assumed solution and the analysis of more complex problems which should include nonhomogeneous boundary conditions, irregular geometries, geometries with several materials, temperature dependent properties, and radiation heat transfer. (F.S.)

13940 (RD/B/N-1250) VOID FRACTIONS IN TWO PHASE FLOW: A CORRELATION BASED UPON AN EQUAL VELOCITY HEAD MODEL. Smith, S. L. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Nov. 1968. 30p. Dep.

A simple physical model describing two phase flow is presented, and compared with a wide range of experimental data. The model assumes that the flow is stratified (annular) with a homogeneous mixture phase and a liquid phase which have the same velocity head, and that the homogeneous mixture of liquid and gas behaves as a single fluid with a variable density. It is also assumed that thermal equilibrium exists. Excellent correlation is obtained, offering a significant improvement over current methods. (UK)

13941 THERMODYNAMICS AND FLUID MECHANICS CONVENTION, HELD IN LONDON, 27-29 MARCH, 1968. Proc. Inst. Mech. Eng. (London), 182: 1-451(1968). (CONF-680323).

Forty-four papers related to single and two-phase fluid flow and heat transfer studies were presented at the convention on thermodynamics and fluid mechanics held in London, England, March 27 to 29, 1968. Separate abstracts were prepared for 5. The remaining 39 papers contain material not within the scope of NSA. (L.C.L.)

For abstracts of individual papers see: 13942–13946.

13942 THERMAL INSTABILITY OF A HEATED ELEMENT COOLED BY FORCED CONVECTION. Rapier, A. C. (United Kingdom Atomic Energy Authority, Windscale, Eng.). Proc. Inst. Mech. Eng. (London), 182: 347-56(1968).

From Thermodynamics and Fluid Mechanics Convention, London, Eng. See CONF-680323.

The behavior of two- and three-span continuous elements was examined using a digital computer programme. The previous solution for elements simply supported at each end was extended to cover any channel shape and any number of spans. Experiments with two- and three-span elements confirmed the predictions. (UK)

13943 STUDY OF LAMINAR CONVECTION FOR FLOW DOWN VERTICAL ANNULI. Sherwin, K.; Wallis, J. D. (Lanchester Coll. of Tech., Conventry, Eng.). Proc. Inst. Mech. Eng. (London), 182: 330-5(1968).

From Thermodynamics and Fluid Mechanics Convention, London, Eng. See CONF-680323.

An experimental study was performed in a vertical annulus of $\frac{3}{4}$ in. ID and $2\frac{1}{4}$ in. OD using water. Flow visualization by dye injection indicated that while small reversed flows may occur in a stable form, higher buoyancy forces give rise to radial components of the flow. These radial components cause the reversed flow regime to become unsteady, and the Nusselt numbers to be higher than those predicted by laminar convection analysis. (UK)

13944 HEAT TRANSFER TO STEAM-WATER MIXTURES FLOWING IN UNIFORMLY HEATED TUBES IN WHICH THE CRITICAL HEAT FLUX HAS BEEN EXCEEDED. Bennett, A. W.; Hewitt, G. F.; Kearsey, H. A.; Keeys, R. K. F. (Atomic Energy Research Establishment, Harwell, Eng.). Proc. Inst. Mech. Eng. (London), 182: 258-67(1968).

From Thermodynamics and Fluid Mechanics Convention, London, Eng. See CONF-680323.

Experiments are described on evaporative heat transfer to boiling water in upflow in a vertical electrially heated 0.497 in. ID tube at 1000 psia. The main objects were to measure the surface temperature profiles in the region beyond the dry-out point in the channel where liquid ceased to flow on the channel wall, and to investigate the behavior of the dry-out "interface" between the "wetted wall" and the "dry wall" regions. The temperature in the "dry wall" region first increased rapidly with distance from the dry-out point, after which it either increased at a slower rate or, at high mass velocities, even decreased. The dry-out "interface" moved reversibly down and up the channel as the heat flux was increased and decreased. Local surface temperatures showed no hysteresis with cycling of heat flux, in contrast with the pool boiling situation. A method of predicting the wall temperature profile in the "dry wall" region was developed. In this method, the heat-transfer process is considered as being in two steps: wall to superheated steam continuum, and steam continuum to water droplets. The first step was calculated from standard single-phase steam heat-transfer correlations, and the second step was calculated on the basis of simultaneous heat transfer to, and steam diffusion from, the droplets. It was important to take account of the slip between the droplets and the steam. Satisfactory agreement was obtained between measured and predicted wall temperature profiles. (UK)

13945 THE DEVELOPMENT OF AN APPARATUS TO MEASURE THE NORMAL EMISSIVITY OF SMALL PLANE SAMPLES IN A CONTROLLED ATMOSPHERE. Furber, B. N.; Broderick, R. (Nuclear Power Group Ltd., Knutsford, Eng.). Proc. Inst. Mech. Eng. (London), 182: 120-9(1968).

From Thermodynamics and Fluid Mechanics Convention, London, Eng. See CONF-680323.

The development and calibration of an apparatus suitable for measuring the normal emissivity of small plane samples at temperatures up to 650°C is described. Though the design of the apparatus was influenced by the special requirements involved in testing magnox specimens, the apparatus has a general application and the normal emissivities of stainless steel, graphite, brass, aluminium, and gold plated stainless steel are also given. (UK)

13946 ADVANCED PROPULSION SYSTEMS IN SPACEFLIGHT. Shepherd, L. R. (Atomic Energy Research Establishment, Winfrith, Eng.). Proc. Inst. Mech. Eng. (London), 182: 1-21(1968).

From Thermodynamics and Fluid Mechanics Convention, London, Eng. See CONF-680323.

The inherent limitations in the use of chemical propellants are discussed, and a detailed examination is presented of the development possibilities of nuclear energy systems. The systems considered include direct open-cycle, and the use of an intermediate closed cycle to generate electricity by direct conversion, or by thermodynamic cycles involving gaseous or condensable fluids or a plasma. Electric arc heating of the fluid, electrostatic ion acceleration, and magnetoplasmadynamic methods are discussed as electrical thrust devices for indirect cycle systems. (UK)

13947 EXTENSION OF A.R.S. CORRELATION TO BURNOUT PREDICTION WITH NONUNIFORM HEATING. Biasi, L.; Clerici, G. C.; Tozzi, A.; Sala, R. (Univ., Milan). J. Nucl. Energy, 22: 705-16(Dec. 1968).

An extension of the A. R. S. correlation to the case of nonuniform heating based on the saturation length hypothesis is presented. The crisis condition is reached when the saturation power, given by the heat balance equation, becomes greater than, or equal to, the critical power given by the correlation. An analytical study of the critical condition for some typical heat flux profiles, i.e., linearly decreasing, linearly increasing, and chopped cosine, was carried out. A comparison between the theory predictions and experimental data from different laboratories can be considered fairly satisfactory. 81% of the data is predicted with an error of less than 10%, and the root mean square error over the whole set is equal to 0.0795. (auth)

Isotope Technology

Refer also to abstracts 13913, 13934, and 14304.

13948 (DP-MS-67-104) B-TYPE $^{244}Cm_2O_3$: A CANDIDATE ISOTOPIC POWER FUEL. Mosley, W. C. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). 1967. 25p. (CONF-680308-14). Dep. CFSTI.

From 155th National Meeting of the American Chemical Society, San Francisco, Calif.

High temperature studies of the thermal decomposition of curium dioxide and the polymorphism of curium sesquioxide indicate that the B-type Cm_2O_3 is the preferred oxide for curium

fuel forms. The monoclinic structure of B-type Cm_2O_3 (a = 14.28 Å, b = 3.66 Å, c = 8.91 Å, and β = 100.39°) with six molecules in the unit cell, corresponds to stoichiometric curium sesquioxide with a density of 11.67 g/cm³. B-type Cm_2O_3 can be produced by decomposition of curium oxalate decahydrate near 900°C in a non-oxidizing atmosphere or by reduction of curium lioxide to bcc C-type Cm_2O_3 and subsequent irreversible (polymorphic) transformation of the C-type oxide to B-type oxide between 800° and 1300°C. The monoclinic B-type oxide, unlike the cubic C-type oxide, resists changes of structure due to α-radiation or reoxidation at low temperatures and remains stable up to 1600°C where reversible transformation to a hexagonal A-type Cm_2O_3 occurs. B-type Cm_2O_3 reoxidizes fairly rapidly between 250 and 520°C, but not at higher temperatures. The narrow composition limits and stability of B-type Cm_2O_3 indicate that it is chemically compatible with capsule materials. (auth)

13949 (DP-MS-68-20) HEATING TESTS OF ENCAPSULATED COBALT HEAT SOURCES. Angerman, C. L.; Faraci, J. P. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). May 24, 1968. 21p. (CONF-681002-4). Dep. CFSTI.

From Nuclear Metallurgical Symposium on Materials for Radioisotope Heat Sources, Gatlinburg, Tenn.

Capsules of nickel- and cobalt-based alloys that contained unirradiated or irradiated cobalt metal wafers performed satisfactorily during heating tests at typical heat source conditions of 10,000 hr in air at 850 to 1000°C. Typical capsules are 1 to 3 in. long and 0.94 in. in diameter with 0.05- to 0.10-in.-thick walls. Cobalt wafers, 0.040 in. thick, were cleaned, measured, and stacked in capsules that are sealed by TIG welding. The best capsule materials, "Haynes" 25, "Hastelloy" X, "Hastelloy" C, and "Inconel" 600, were selected from screening tests that were designed to measure the kinetics of the three most important factors affecting the integrity of the heat source capsule: (1) reaction between the cobalt and the capsule; diffusion of ^{60}Co through the capsule wall; and oxidation of the exterior capsule surface. Extrapolation of results from these short-term tests indicates that capsule performance would be satisfactory up to 1000°C for service times out to 50,000 hr. Capsule heating tests are continuing to conform predicted performance to 5 yr. (auth)

13950 (NYO-3491-3) GENERATION AND PRACTICAL USE OF MONOENERGETIC X-RAYS FROM ALPHA EMITTING ISOTOPES. Final Report. Sellers, Bach; Wilson, Henry; Hanser, Frederick A. (Panametrics, Inc., Waltham, Mass.). Oct. 1968. Contract AT(30-1)-3491. 101p. Dep. CFSTI.

The production of fluorescent x-rays by alpha particles has been investigated experimentally and theoretically. Available alpha particle sources were investigated and evaluated. A theoretical discussion, necessary for a more complete understanding of the fluorescent yield experiments, leads to an approximate expression for the K shell ionization cross section for a heavy charged particle. This allows a theoretical calculation of K shell x-ray yields, which prove to be somewhat larger than the experimental thick target yields for 2.5 MeV alpha particles. The experimental thick target x-ray yields are found to depend primarily on the x-ray energy and not on the x-ray shell (for K, L, M). K shell ionization cross sections for aluminum and magnesium were measured and found to be smaller than theory at 1 MeV, and larger than theory at 5 MeV. These results are compared with other work using protons, alpha particles and ^3He particles. Application to a lunar-planetary surface composition analyzer is discussed, as well as the use of alpha excited fluorescent x-rays for instrument calibration. Recommendations for future work are given. (auth)

13951 (ORNL-4340) PREPARATION OF ^{90}Sr SILICATE BETA SOURCES. Mackey, T. S.; Case, F. N. (Oak Ridge National Lab., Tenn.). Feb. 1969. Contract W-7405-eng-26. 21p. Dep. CFSTI.

A process has been developed for producing high-integrity beta sources by embedding strontium silicate beads in an aluminum matrix contained in an outer capsule of stainless steel. The procedure consists in preparing strontium silicate feed for a bead-forming furnace, forming beads at 2000°C, and fabricating the final source form by encapsulating the beads in molten aluminum. Strontium silicate was precipitated from an aqueous solution of strontium nitrate with a commercial quaternary ammonium silicate. The precipitate was then processed into the feed material, which consisted of particles ranging in size from 50 to 100 mesh. Beads were formed by dropping the strontium silicate feed through a graphite tube heated to ~2000°C. Stainless steel capsules were filled with beads through a small hole drilled in one end plug. Molten aluminum was forced into the capsule by atmospheric pressure to form a matrix completely enclosing each bead, and the final seal was made by Heliarc-welding a stainless steel plug into the fill hole. Tests made on prototype sources containing nonradioactive strontium silicate indicated that these sources possess excellent physical properties. (auth)

13952 (TID-24823) DIVISION OF ISOTOPES DEVELOPMENT RESEARCH AND DEVELOPMENT PROJECTS: 1968. Progress Reports on Sponsored Work. (Division of Isotopes Development (AEC), Washington, D. C. Oak Ridge National Lab., Tenn.). Jan. 1969. 343p. Dep. CFSTI.

Summaries of the objectives, results, and future plans for each research and development project sponsored by the Division of Isotopes Development, U. S. Atomic Energy Commission, are presented. The program areas covered are: radioisotope production and materials; thermal applications development; environmental and ocean sciences; radiation analysis and control; radiation engineering; radiation processing applications development; radiation preservation of foods; and analysis and evaluation. (R.C.K.)

13953 (WANL-3800-25) SNAP-23A, PHASE 1. Quarterly Progress Report, September 1-November 30, 1968. Wilgus, W. S. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). Dec. 20, 1968. Contract AT(30-1)-3800. 150p. (WANL-PR-SS-22). Dep. CFSTI.

Design revisions, evaluations, quality control, reliability, and technical progress are reviewed. Thermal testing of the Experimental Mockup System was conducted on all components and the data are tabulated and analyzed. The design of the shipping cask for SNAP-23A heat source/generator was reviewed. Shock and vibration testing was completed with no structural damage or change of systems performance characteristics. Spherical insulation tests were performed and analyzed. Testing consisted of measurements with Min-K 2000 material in air, argon, nitrogen, and under vacuum environments and with Min-K 2002 material in air and argon atmospheres and under vacuum. Data analyses are reported in terms of thermal conductivity as a function of temperature. U-8 Mo samples were exposed to 180°F water for 24 hours for oxidation evaluation. Creep-rupture tests on U-8 Mo continued. The SNAP-23A biological shield assembly was tested to determine the effectiveness of the assembly for attenuating the radiation from the $SrTiO_3$ fuel capsule. Structural overpressure problems for SNAP-23A are investigated. Safety analyses are reviewed. (J.C.W.)

13954 QUANTITATIVE ELECTRODEPOSITION OF ACTINIDES FROM DIMETHYL SULFOXIDE. Handley, Thomas H.; Cooper, J. H. (Oak Ridge National Lab., Tenn.). Anal. Chem., 41: 381-2(Feb. 1969).

A simple, quantitative, and fast technique for preparing sources for analytical alpha spectrometry by electrodeposition from dimethyl sulfoxide was developed. In the presence of fluoride ion, sexivalent americium was preferentially electrodeposited with respect to the trivalent curium ion. A decontamination factor of several hundred was obtained. (D.H.M.)

13955 DEVICE FOR PREVENTING DAMAGE TO RADIOACTIVE SOURCES IN LEAD-FILLED TRAYS OR DRAWERS. Bedrosian, Paul H. (to Secretary of the Department of Health, Education, and Welfare). U. S. Patent 3,419,320. Dec. 31, 1968. Filed Aug. 29, 1967.

A mechanical safety device having a rectangular metal frame which is hinged to a bar along one long side is described. A pivoted, spring-loaded cam unit is provided which, when held in the cocked position, lies within the open space of the frame and does not protrude above the upper plane of the frame member to which it is attached. The cam is locked by a pin which fits into a notch on the side of the cam. This pin is part of a spring-loaded cover unit which is hinged, by removable pins, to the frame at its side opposite the cam. When the cover is in locked position, it lies in the horizontal plane and is flush with the upper surface of the frame. In operation, the frame is attached by the hinged bar to a lead-filled tray or drawer holding radioactive sources such as needles. When the sources lie properly within the tray or drawer, the safety device, with the cover closed against the frame, can be lowered on them and the drawer can be closed. If any of the sources protrude above the top of the drawer, the source will strike the cover from the bottom thereof causing the pin on the cover to disengage the cam which will then spring into position such that it will prevent the frame of the device from resting completely on the tray. With the frame elevated by the sprung cam, the drawer cannot be closed preventing accidental damage to the sources. (Offic. Gaz.)

13956 CONTINUOUS MEASUREMENT OF LINING WEAR IN STEEL FURNACES WITH RADIOISOTOPES. Bergh, S.; Sandberg, H.; Stahl, N. (Domnarfvets Jernverk, Sweden). J. Metals, 21: 19-22(Feb. 1969).

A method for measuring the lining wear in a rotating steel furnace is based on determination of the activity of the steel bath when radioactive material placed in the bricks is continuously dissolved at a rate proportional to the wear of the lining. The method is a simple, rapid, reliable and inexpensive way to determine the lining wear without interfering with production. The reproducibility of the measurement is ±5%. It is now possible to obtain statistically reliable relation between metallurgical variables and lining wear. Radioactive iridium-192 tracers are placed in the lining bricks during manufacture. (J.C.W.)

13957 RADIOISOTOPIC HEAT SOURCE AND METHOD OF PRODUCTION. Fitzgerald, Joseph J.; Brownell, Gordon L. (to Iso/Serve, Inc.). U. S. Patent 3,421,001. Jan. 7, 1969. Filed Mar. 16, 1964.

A nonradioactive encapsulated heat source adapted to be converted by exposure to neutron flux to an isotope fueled heat source is described. It consists of a wafer of a stable compressed sintered isotope having a cross section of greater than 5 barns to thermal neutrons and a half life in excess of 100 days. The wafer is entirely contained and enclosed in a sealed capsule of material which has a melting point in excess of 2300°C. The capsule is nonreactive with the isotope compound, can be joined to it, and has a cross section of less than 0.2 barn to thermal neutrons and a half-life of less than 3 days. (auth)

13958 POSSIBLE MEANS OF INCREASING THE INTENSITY OF RADIATION FROM RADIOACTIVITY APPLICATORS. Bogoyavlenskii, A. F.; Belov, V. T.; Kiselev, I. P.; Vagina, I. A. Tr. Kaz. Aviats. Inst., Ser. Khim., No. 90, 59-63(1966). (In Russian).

Experimental investigation aimed at clarifying whether β-radiation from a radioactivity applicator (as recorded by a counter) can be intensified with the aid of a reflector. It is found that by using aluminum and lead reflectors the radiation can be intensified by 200 and 300%, respectively, and that the increase in intensity also depends on the shape of the reflector. The increase obtained with reflectors having a spherical bottom exceeds by 150% the increase in the case of a flat bottom. (IAA)

13959 THE POTENTIAL MODEL FOR HELIUM–HYDROGEN INTERACTION IN THERMAL DIFFUSION. Van De Ree, J.; Los, J.; De Vries, A. E. (FOM-Instituut voor Atoom- en Molecuulphysica, Amsterdam). Physica, 34: 66-80(1967).

The thermal diffusion factors α of small concentrations of all possible hydrogen isotopes were measured in ^3He and ^4He between 100 and 500°C and compared with the values from the Chapman-Enskog theory. It appeared that a Buckingham potential model with parameters from viscosity and second virial coefficients, could fit the separations of the symmetric molecules H_2, D_2 and T_2. It was, however, impossible to fit the values of the asymmetric molecules HD, HT and DT into the Chapman-Enskog theory. An analysis of possible sources of deviations, such as higher order approximations, quantum corrections or inelastic collisions, gave no improvement of the theoretical values. The effect has to be found in the angular dependence of the intermolecular potential, originated by the shift of the center of mass of the molecule, which is, however, out of the scope of a spherically symmetric theory. The situation is in complete agreement with the mutual thermal diffusion of hydrogen isotopes. Both series of experiments could be described by the following approximate formula $\alpha = c[(M_1 - M_2)/(M_1 + M_2)] + d - e/2 \mid [(M_A - M_B)/(M_1 + M_2)] \mid$, M_1 and M_2 are the molecular masses of the two components, M_A and M_B the atomic masses in the molecule M_1. The two constants, c and d, for the symmetric molecules, follow immediately from the Chapman-Enskog theory, whereas the constant e gives the deviations of the asymmetric molecules. (auth)

13960 RADIOACTIVE PRODUCTS, 1969/70. Amersham, Eng., Radiochemical Centre (UKAEA), 1969. 216p.

This catalogue includes information on ordering and supply of RCC radioactive products, licensing and registration, product specifications and prices, tritium and ^{14}C labeling services, reactor irradiation services, surface applicators, β-teletherapy sources, extracorporeal irradiators, ophthalmic applicators, interstitial and intracavitary appliances, gamma sources for teletherapy, alpha foils and sources, beta and positron sources, Moessbauer sources, bremsstrahlung and gamma sources, gamma radiography sources, sources for industrial irradiation and research, demonstration and training sources, neutron sources, targets for neutron generators, alpha, beta and gamma reference sources, standardised radioactive solutions, reference material for liquid scintillation counting, quality control, and applications of radiation sources. (UK)

Materials Testing

Refer also to abstracts 14085, 14104, and 14112.

13961 (BNWL–902) AN INVESTIGATION OF ACOUSTIC EMISSION FROM DEFECT FORMATION IN STAINLESS STEEL WELD COUPONS. Day, C. K. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan. 1969. Contract AT(45-1)-1830. 41p. Dep. CFSTI.

Results of an exploratory investigation to determine capabilities and limitations of acoustic emission techniques for detecting weld defects are presented. Acoustic emissions reveal cracks while they form during the welding operation; data indicate that gross porosity can also be detected with this technique. Interference signals, similar to acoustic emissions from bonafide weld defects, can be produced by scale flaking away from the weld surface, by electromagnetic interference, and by impact on the weld material by tools, welding rods, and other metal objects. Suggestions for reducing the effects of interference signals are included. (auth)

13962 (BNWL-SA-2274) TRENDS IN IRRADIATED FUELS AND MATERIALS EXAMINATION. Cunningham, G. W.; Evans, E. A.; Hanson, J. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan. 6, 1969. Contract AT(45-1)-1830. 9p. (CONF-690305-1). Dep. CFSTI.

From Remote Handling and Examination in the Fast Reactor Field Meeting, Idaho Falls, Idaho.

Trends in irradiated fuels and materials examinations show that post-irradiation examinations are becoming more complicated and more detail and precision are continually being demanded from them. Because of dramatic increases in the number of well characterized fuel and material specimens, considerable thought and emphasis must be given to remote system technology to obtain the maximum information from these irradiation experiments. The large numbers of specimens to be examined will require the application of automation and electronic data processing to minimize costs and time. Basic or research-oriented fuels and materials studies will require more sophisticated examination facilities to accommodate reactive materials and provide greater accuracy and precision of measurements. Additionally, such studies will require application of in-reactor diagnostics to better understand the behavior of fuels and materials under irradiation. (auth)

13963 (ORNL–4352) DEVELOPMENT OF NONDESTRUCTIVE TESTS FOR INTERMEDIATE FABRICATION OF SINTERED ALUMINUM PRODUCTS. Whaley, H. L. (Oak Ridge National Lab., Tenn.). Feb. 1969. Contract W-7405-eng-26. 28p. Dep. CFSTI.

Several techniques for nondestructive evaluation of sintered aluminum powder materials was developed. An entirely new air-settling technique for measuring flake thicknesses of powders, adapted eddy-current techniques and equipment for determining oxide content in both powders and extrusions, and applied x-ray attenuation techniques to measuring the homogeneity of extruded billets were developed. Equipment and results are described in detail for each test method. (auth)

13964 CONTRIBUTION TO THE ORIGIN OF WEAR FROM TENSILE STRESS IN THIN LAYERS OF LUBRICATING OIL. Brendel, Horst (Technische Hochschule, Karl-Marx-Stadt, Ger.). Wiss. Z. Tech. Hochsch. Karl-Marx-Stadt, 9: 135-47(1967). (In German).

Wear in the test device was measured by a modification of neutron activation. The upper surface of the device was irradiated, producing ^{59}Fe, whose β activity was measured by a G–M counter; the activity of ^{51}Cr was also followed after its production in the steel. About 100 mCi of each isotope was produced. The lower plate remained unirradiated, so that after the experiment mass transfer to this surface could be determined by incorporated activity. This was measured by a VA-M-14 device with a G–M counter. The mass in the lubricating oil was determined after the application of extraction techniques. Improvement of the basic experiment permitted analysis of local effects in the oil layer, and studies as a function of time. Experimental results are discussed with reference to an approximation technique for prediction of wear. (BBB)

13965 WHEN ARE WELD DEFECTS REJECTABLE? [PART I]. Thielsch, Helmut (Grinnell Corp., Providence). Mater. Eval., 27: 25-33(Feb. 1969).

Methods for determining the cause and magnitude of weld defects and for evaluating the contribution of such defects to service failures of welded materials are discussed. (L.C.L.)

13966 NONDESTRUCTIVE INSPECTIONS OF WELDS. CLASSIFICATION OF RADIOGRAPHS FOR WELDS. Senda, Tomio (Osaka Univ.). Yosetsu Gakkaishi, 37: 942-52(Sept. 1968). (In Japanese).

Standards for the radiographic inspection of welds are discussed. Difficulties in the use of the standard are described.

To cope with the situation, the inspection by Irradiation Committee of Japan Welding Engineering Society, Welding Techniques for Light Metals Society, and Japan Nondestructive Inspection Society established their own standards, and the new JIS standard enacted for welds of steel and aluminum. The method for classifying and taking radiographs in the standard "The Radiographic Testing Method and the Classifying Method of Radiographs for Steel Welds JIS Z 3104" are explained. (NSA of Japan)

Protective Structures

13967 (TT-67-51409/4, pp 387-92) STANDARDS FOR NATURAL RADIOACTIVE SUBSTANCES IN BUILDING MATERIALS. Afanas'ev, M. K.; Krisyuk, E. M. Translated from Gig. Sanit., 32: No. 12, 64-7 (Dec. 1967).

Varying amounts of naturally radioactive substances, such as ^{40}K, Th, U, and their decay products, are present in all natural materials, and therefore in materials used in the construction of dwellings. The effects of both gamma-radiating isotopes and other radioactivity in building materials on the gamma-background levels in the buildings and the radon and thoron levels in the indoor air are discussed. The safety standards derived for the maximum permissible concentration of radioactive substances in building materials were: 0.002% equilibrium Th and V, or 2×10^{-11} Ci/g of the total ^{210}Pb, ^{210}Po, ^{226}Ra, ^{228}Ra, ^{228}Th, ^{230}Th, and ^{234}U. (L.C.L.)

Radioactive Material Handling

Refer also to abstracts 13828, 13852, 13854, 13904, 14161, and 14162.

13968 (CONF-690103-8) AERIAL DETECTION AND RECOVERY OF A ^{60}Co SOURCE LOST IN INTERSTATE SHIPMENT. Eskridge, Harold E.; Hand, John E. (EG and G, Inc., Las Vegas, Nev.). [nd]. 7p. Dep. CFSTI.

From Health Physics Society Midyear Topical Symposium, Los Angeles, Calif.

The successful uses of airborne gamma radiation detection instruments to locate a 325 mCi ^{60}Co source lost during truck transport is described. (L.C.L.)

13969 RADIATION SHIELDING VESSEL. Hirasawa, Yoshiya (to Mitsubishi Atomic Power Industry, Inc.). Japanese Patent 1968-23120. Oct. 4, 1968. Filed Dec. 9, 1965.

A simplified method of providing joint-free radiation shielding for a cylindrical container is described. One end of a wide neutron-shielding belt is spot welded along the length of an inner cylinder. The belt is then wound around the cylinder a suitable number of times. One end of a wide gamma-ray shielding belt is inserted under the neutron shielding belt. The two belts are together wound around the cylinder. The termination of winding differs from one belt to the other belt, each end being spot welded. Finally, an outer cylinder is placed over the wound whole. (NSA of Japan)

13970 CONTAINER FOR A FAILED FUEL. Yoshinaga, Toshiaki (to Hitachi Ltd.). Japanese Patent 1968-22796. Sept. 25, 1968. Filed Dec. 4, 1964.

A container for receiving and transporting a spent fuel element from a swimming pool reactor is described. Sections of a spent fuel element, obtained by cutting, are placed in the container in the pool water with remotely operated tongs. This operation is simple due to the design and construction of the container lid. The container consists of the following: a cylindrical container body; a cover attached to the open end of the cylindrical body which has holes on the inside surface circumferentially; and a plug with a handle on the top end which has the corresponding holes on the outside surface circumferentially. The plug has a "tapered in the direction of the cover" claw installed in each hole, with pressure outwardly by a spring within it. By this means, when the plug is inserted into the inside of the cover, the claws engage the cover there-by closing the container body. (NSA of Japan)

13971 CONTAINER FOR A RADIOACTIVE MATERIAL. Yoshinaga, Toshiaki (to Hitachi Ltd.). Japanese Patent 1968-21276. Sept. 6, 1968. Filed Jan. 20, 1965.

A device for containing radioactive materials is described which has the following advantages: ease of closing using tongs; and complete elimination of radioactive gas leakage. The lid which is a circular plate is placed on the underside of the top end and has a large hole through it and the container body. The plate, rotatable with one end as the pivot, is always pressed against the underside by means of a spring. A vertical hole is cut through the "upright" wall from the top end for a certain distance; a small diameter hole runs from the bottom of the said hole opening into the interior of the container body at a point a little below the plate. A bolt, with an axial small-diameter hole cut through it, is screwed halfway into the "wall" hole; the bottom end is made into the shape of a cone. A small sphere is pressed against the cone from below, by means of a spring. After placement of a radioactive material in the container and thus closure by the plate, a gas is introduced from the "bolt" hole into the container interior, in order to press the plate more firmly against the said underside. (NSA of Japan)

13972 CONTROL FOR A TRAVELLING CRANE. Bonnaure, Pierre (to EURATOM). British Patent 1,142,488. Feb. 5, 1969. Priority date Dec. 17, 1965, Belgium.

A control system for a traveling crane such as is used in fuel element charging and discharging at a reactor is described. The system consists of a pin, means for attaching the pin in an upright position to an article to be moved, a frame to encircle the pin, a method to orient the frame, and a means to convert the response of the fuel element being moved into a signal which causes the crane to move in the required direction. (F.S.)

13973 WASTE DISPOSAL SYSTEMS. Takiguchi, Yukio; Ishikura, Takeshi. Toshiba Rebyu, 24: 58-64 (Jan. 1969). (In Japanese).

Waste disposal systems for BWR plants, constituting circuits introducing radioactivity directly into turbine systems, are generally constructed in larger scale than general disposal systems, in view of the management of radioactivity over the whole plant. Fundamental concepts of the systems as well as the ideas and problems concerning their design are treated. (NSA of Japan)

INSTRUMENTATION

Radiation Detection Instruments

General Detectors and Monitors

Refer also to abstracts 13668, 13950, 13968, 14220, 15346, and 15432.

13974 (BNWL–715(Pt.2), pp 181-225) RADIOLOGICAL PHYSICS. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

BIOLOGICAL MATERIALS — radiation effects on, hit theory associated with
COMPUTER PROGRAMS — for comparison of statistical parameters of proton energy loss distributions in thin tissue-like materials
ELECTRONS — analysis of delta-ray, produced in heavy charged particle reactions with matter at high-energies
MAN — analysis for total-body phosphorus by isotope dilution and in vivo fast-neutron activation, bone mass measurements from
MATHEMATICS — Poisson series in, method of computing
PHANTOMS — proton energy loss distributions in thin tissue-like, analysis of statistical parameters of
PROMETHIUM — uptake, distribution, and excretion in man
PROTONS — reactions with gaseous targets, energy and angular distribution of ejected electrons from
— reactions with muscle-equivalent plastic, measurement of endothermic processes in
RADIATION DETECTORS, PROPORTIONAL — design of spherical wall-less, for microdosimetry
— testing of Benjamin-type, for microdosimetry
— design of spherical, composed of tissue-equivalent plastic for neutron dosimetry in mixed gamma-neutron field
— gas pressure control for flow-type
RADIATION DOSIMETERS, CALORIMETRIC — design for measurement of endothermic processes in muscle-equivalent plastic
RADIATION TARGETS — proton reactions with gaseous, energy and angular distribution of electrons ejected from (B.G.D.)

13975 (CEA-CONF–1035) STATIONARY GAS DETECTOR AND A NEW TYPE OF GAMMASCOPE. Lansiart, A.; Lequais, J.; Roux, G.; Morucci, J. P.; Gaucher, J. C. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). [1968]. 24p. (In French). (CONF-680804–8; SM–108/135). Dep.

From Symposium on Medical Radioisotope Scintigraphy, Salzburg, Austria.

Various techniques applied to scintillation and avalanche chambers, studied at the Service d'Electronique Physique at Saclay, are reported. These detectors are filled essentially with xenon. Three plane electrodes outline two areas: one of large dimension is the detection area and the other of much smaller dimension is the electronic amplification area. A transparent semiconductor deposit on glass limits the current in the scintillations; a shunt placed at the edges of the amplification area reduces the energy consumed in the gas. The operation is improved by choosing for the organic vapor a gas having an ionization potential close to that of the first excitation level of xenon (role of diethylamine). The first industrial version is presented. The shunt was also adapted to avalanche operation. In this case a preamplifier of the avalanche signals is connected to the grid. Finally a new anode structure is presented: the tin oxide deposit is fractionated into twenty regions and the shunt suppressed. Each region has its own dead time; the dead time of the detector is reduced. A new registration mode of the scintillations produced in a NaI(Tl) crystal is presented. The crystal or crystal mosaic is placed against the window of an amplifier and image reducing tube (input diameter 200 mm and output diameter 25 mm). Four photomultipliers show the position of the scintillation on the output screen. (tr-auth)

13976 (CEA-CONF–1049) CALCULATION OF THE PRECISION OF NEUTRON MEASUREMENTS IN THE CASE OF BURSTS OF SEVERAL MICROSECONDS: CORRESPONDING EXPERIMENTAL EQUIPMENT. Launois, M.; Hebert, M. M.; Pelissier, M. A. (Societe Anonyme d'Etudes et Realisations Nucleaires, Limeil-Brevannes (France)). Jan. 8, 1968. 27p. (In French). (CONF-680302–8). Dep.

From International Symposium on Nuclear Electronics and Radioprotection, Toulouse, France.

The characteristic instants of bursts corresponding to the emission of 10^3 to 10^6 neutrons in 4π steradians are materialized in the form of electric pulses which can be applied to time interval counters. The precision of the measurement of the characteristic instants can be determined if the parameters of the detector are known. The detector parameters (variation of the number of neutrons entering in the solid angle Ω, detection efficiency of the scintillator, energy distribution of the recoil protons, response of the scintillator and of the optics of the light generator, response of the photocathode and of the input optics of the photomultiplier, and the response of the electron multiplier) were calculated. First the principle of measurement using this mode of calculation was summarized. The calibration of the measurement chain is described and the particular apparatus used is discussed. From the theoretical calculation numerical values are obtained. An experimental verification was made of the theoretical results. (J.S.R.)

13977 (CEA-CONF–1067) MEASUREMENT OF FAST NEUTRON FLUX BY MEANS OF SILICON DIODES SENSITIVE TO DAMAGE. de Cosnac, B.; Dulieu, P.; Le Ralle, J. C.; Manent, G. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). [1967]. 29p. (In French). (CONF-680302–6). Dep.

From International Symposium on Nuclear Electronics and Radioprotection, Toulouse, France.

Silicon PIN junctions were used for the dosimetry of fast neutrons. The inverse of the reversal time varies proportionally with the integrated neutron flux. This property was used to measure the fast neutron flux, and the diodes were calibrated in a reference flux. An annealing method made it possible to suppress the errors due to the return to room temperature and to extend the region of utilization of the detector. The measuring technique and the apparatus made it possible to limit the errors due to the temperature variations at the moment of measurement. The advantage of this detector, whose response to the energy of neutrons was studied theoretically and experimentally, is its sensitivity to neutrons with energy weaker than threshold activation detectors. (tr-auth)

13978 (CEA-CONF–1151) RISE TIME-TO-AMPLITUDE CONVERSION. APPLICATION TO IDENTIFICATION OF PARTICLES. Prieur-Drevon, M. ([Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires]). [nd]. 12p. (In French). (CONF-680906–15). Dep.

From International Symposium on Nuclear Electronics, Versailles, France.

The converter described provides output signals the amplitude of which is proportional to the rise time of the input pulses in the range of 20 ns to 1 μs. It may be used with a multichannel pulse-height analyser to obtain the pulses rise time spectrum. The apparatus includes two circuits for triggering at a constant fraction of the amplitude of the input pulse for providing start and stop pulses to a time-to-amplitude converter. It is employed with a hydrogen proportional counter to achieve neutron-γ separation. (auth)

13979 (CEA-CONF–1167) DETECTION AND CONTROL OF TRITIUM CONTAMINATION; EQUIPMENT USED IN SURVEILLANCE OF THE LABORATORIES. Baron, H.; Burkhart, A.; Debiar, A. (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes). [1967]. 14p. (In French). (CONF-681013–7). Dep.

From 1st European Congress on Radiation Protection and Exhibition on Equipment Using Low Energy and Short Range Radiation Dosimetry, Menton, France.

Handling in large quantities tritium monitoring of contamination has been realized in a chemical laboratory with the following aims: continuous monitoring of laboratory atmosphere, centralization and automatic processing of information, localization of the incident origin, recording of the information, and individual safety of workers. For this purpose static and air flow ionization chamber located at the sensible spots (ventilation ducts, inside of glove boxes, extraction nozzles of the cell, exhaust of vacuum pumps) and suitable for the specific requirements of the monitoring to be carried out are used. The informations obtained are centralized, if necessary, outside of the laboratory, for taking emergency measures only when the hazards involved are fully known. The detectors used, the locations selected, and the centralizations realized are presented and a description is given of the calibration methods used. (auth)

13980 (CEA-CONF-1169) IMPROVEMENT OF THE SIGNAL-TO-NOISE RATIO IN NANOSECOND AMPLIFICATION. Lavaitte, A. [nd]. 11p. (In French). (CONF-680906-12). Dep.

From International Symposium on Nuclear Electronics, Versailles, France.

Amplifiers utilizing the current sensitive mode for use with semi-conductor radiation detectors require broad bandwidth and high gain. The noise generated by these amplifiers disturbs time information and energy resolution and limits the sensitivity. An amplifier is described which uses a method of distributing the signal on four paralleled ways of amplification, the outputs of which are linearly summed. By this means the amplitude spectrum of the noise pulses is compressed toward low levels. (auth)

13981 (CEA-CONF-1190) USE OF A COMPUTER FOR AUTOMATIC MEASUREMENT OF ABSOLUTE ACTIVITY OF RADIONUCLIDES. Robin, G.; Miguel, P.; Figdor, H. G.; Keroe, E. A.; Gallice, P. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). July 9, 1968. 16p. (In French). (CONF-680906-20). Dep.

From International Symposium on Nuclear Electronics, Versailles, France.

The design of a system using an EMD/8/48 computer with a coincidence circuit using a $4\pi\beta$ proportional counter and a thallium-activated sodium iodide scintillation counter is described for automatically measuring the activity of radionuclides. (W.H.K.)

13982 (CEA-CONF-1203) NEUTRON GAMMA DISCRIMINATION CIRCUIT. Adam, A.; Cabe, J.; Cance, M.; Laurat, M.; Ponce, J. C. (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes). [1966]. 7p. (In French). (CONF-681208-1). Dep.

From Conference on Experimental Methods in Nuclear and Particle Physics, Strasbourg, France.

A neutron–gamma discrimination circuit from the Roush principle is presented which allows a good separation between electrons and recoil protons of energy above 150 keV in a scintillation detector. This circuit has a very good efficiency. It leaves the anode of the photomultiplier free for time-of-flight measurements. (auth)

13983 (CSIR-281) STANDARDIZATION OF ^{109}Cd. Steyn, J. (Council for Scientific and Industrial Research, Pretoria (South Africa). National Physical Research Lab.). 1969. 12p. Dep.

Two methods for the standardization of the nuclide cadmium-109 based on the liquid scintillation counting of internal conversion electrons are described. Results obtained by the two methods differ systematically by about 2%. (auth)

13984 (DUN-SA-76) MULTIPURPOSE RADIATION MONITORING SYSTEM. Owen, F. E. (Douglas United Nuclear, Inc., Richland, Wash.). Jan. 15, 1969. Contract AT(45-1)-1857. 16p. (CONF-690103-10). Dep. CFSTI.

From Health Physics Society Midyear Topical Symposium, Los Angeles, Calif.

Design of the multipurpose radiation monitoring system used at the Hanford Production Reactors is described. (W.H.K.)

13985 (KURRI-TR-5) CALIBRATION OF THE LARGE, FLOW-TYPE IONIZATION CHAMBER FOR MONITORING THE "KUR" STACK GAS. Sumino, Teruie; Sekitani, Koichi; Kotani, Koichi; Tsujimoto, Tadashi; Katsurayama, Yukinori ([Kyoto Univ. (Japan). Research Reactor Inst.]). Aug. 19, 1965. 13p. (In Japanese). Dep.

A large, flow-type ionization chamber assembly was installed on the stack of the reactor building of the KUR (Kyoto University Reactor) to monitor the effluent gas in order to control the radioactive release to the environment. For calibration, air contained in a sealed polyethylene bottle was irradiated in the reactor, and the neutron dose received by the bottle was measured with a gold foil placed in the bottle. The ^{41}Ar produced by the activation of air was used to calibrate the monitoring instrument. The monitoring unit consisted of two cylindrical ionization chambers; the upper chamber was used for compensating the gamma radiation; the lower one for the actual measurements. The stack gas was blown from the lower section of the stack into the ionization chambers and returned to the stack. The output was measured with a vibrating reed electrometer and converted to the concentration of radioactive gas. The detection sensitivity of the monitor after background correction was found to be 2.8×10^{-8} μCi/cc. Assuming that ^{41}Ar will be the only radioactive gas released by the stack, this monitor is sufficiently sensitive to detect releases at the maximum permissible concentration level. (TTT)

13986 (KURRI-TR-6) CALIBRATION OF INSTRUMENTS USED TO MONITOR SURFACE CONTAMINATION DENSITY. Sumino, Teruie; Sekitani, Koichi; Tsujimoto, Tadashi; Katsurayama, Yukinori (Kyoto Univ. (Japan). Research Reactor Inst.). Oct. 14, 1965. 26p. (In Japanese). Dep.

The calibration of the surface contamination survey meters is an important item in the radiation control program at the Kyoto University Reactor Research Institute. The calibration standard specified by the JIS (Japan Industrial Standards) is used for the hand, foot, and clothes counter. The following method was used to prepare a special calibration for all other survey instruments. Crystalline U_3O_8 was ground into a fine powder and suspended in ethanol. The suspension was pipetted onto steel plate, and spread out evenly with a glass rod and dried to leave a thin layer of uranium oxide on the plate. The uniformity of uranium oxide dispersion was ±26.5% over the entire surface. This plate then was used to determine the calibration constants, sensitivity of detection, and other calibration characteristics of survey instruments which included a floor monitor, a Toshiba survey meter, and a large-area Aloka survey meter. Both the 4.18 MeV α and 2.31 MeV β radiation emitted by this standard can be utilized. When desired, the α radiation can be screened off with 25 mg/cm^2 aluminum foil to count only the β radiation. The various survey meters used are described. (TTT)

13987 (IS-1986) COMPUTER PROGRAM FOR AUTOMATIC ANALYSIS OF SEMICONDUCTOR DETECTOR SPECTRA. Taff, L. M.; Champion, P. M. (Ames Lab., Iowa). Nov. 1968. Contract W-7405-eng-82. 66p. Dep. CFSTI.

A computer program is described which accepts a Ge(Li) detector spectrum, finds peaks in the presence of statistical fluctuations in the data using the method of Mariscotti, fits each peak with a Gaussian and quadratic background function, and produces convenient tabular results and plotted graphs. Ease of use and adaptability were major programming considerations. Complete instructions and a listing of the program are given. (auth)

13988 (N-68-35152) AN ANNULAR LITHIUM-DRIFTED GERMANIUM DETECTOR FOR STUDYING NUCLEAR REACTION GAMMA RAYS. Levy, A. J.; Ritter, R. C.; Ziock, K. (Virginia Univ., Charlottesville. Dept. of Physics). (NASA-CR-1138).

A fabrication technique was developed for truly annular Ge(Li) gamma detectors. Featuring spark-cutting to precisely control the undamaged germanium volume, the detector is capable of standard-geometry techniques such as are used with NaI detectors. Background material relevant to the annular geometry is presented. An extremely explicit, detailed description of the complete fabrication procedure is given, including special cutting, radiant diffusion, and drifting techniques developed here. Measured properties of several detectors are presented, with the emphasis being on the usefulness of the detector high energy gamma ray spectra. (auth) (STAR)

13989 (RT/EL-(68)4) COORDINATION OF ACTIVITIES IN THE FIELD OF ELECTRONICS AND INSTRUMENTATION. Report No. 4. Rispoli, B. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1968. 122p. (In Italian). Dep.

A separate abstract was prepared for one of the three sections presented. Two of the sections were not within the scope of NSA and were not abstracted. (B.G.D.)

For an abstract of individual section see: 13990.

13990 (RT/EL-(68)4, Paper 2) CHARGE PREAMPLIFIER WITH LOW NOISE AND HIGH STABILITY FOR NUCLEAR SPECTROMETRY WITH SEMICONDUCTOR DETECTORS. Coiante, D.; D'Urso, G. (Comitato Nazionale per l'Energia Nucleare, Casaccia (Italy). Centro di Studi Nucleari). 59p. (In Italian). (RT/EL-(68)6).

The energy resolution and the stability of a low-noise preamplifier for nuclear spectrometry with semiconductor detectors are discussed. The principal circuits of such a preamplifier are proposed. The output stage is designed and the thermal coefficient of the gain is estimated. The preamplifier was constructed, and the experimental measurements of the voltage gain, noise, linearity, and thermal coefficient are reported and compared with the theoretical predictions. (J.S.R.)

13991 (TT-67-51409/4, pp 77-80) NOMOGRAMS FOR THE DETERMINATION OF TIME AND RELATIVE STATISTICAL ERRORS IN RADIOMETRIC MEASUREMENTS. Borovkov, I. I. Translated from Gig. Sanit., 32: No. 10, 67-9 (Oct. 1967).

Nomograms are presented for the determination of root-mean square relative error in accordance with the total number of pulses, for the determination of the error from the difference and the sum of pulses from the background and from the preparation plus the background recorded over the same period, and for the measurement time of the background and of the preparation plus the background. (W.H.K.)

13992 (TT-67-51409/4, pp 376-9) AUTOMATIC STATION FOR RECORDING GAMMA-BACKGROUND. Borovkov, I. I. Translated from Gig Sanit., 32: No. 12. 54-7 (Dec. 1967).

A cycle timer is described to give brief periodic actuation of a detector unit for continuous automatic recording of natural gamma background. (W.H.K.)

13993 (UCRL-71507) TRAPPING EFFECTS IN Ge(Li) DETECTORS: AN INTERIM PROGRESS REPORT. Armantrout, G. A. (California Univ., Livermore. Lawrence Radiation Lab.). Jan. 20, 1969. 40p. (CONF-690104-1). Dep. CFSTI.

From American Society for Testing and Materials Meeting, Gaithersburg, Md.

The causes and nature of the trapping and tailing problem associated with Ge(Li) detectors are discussed. Observations on actual detector performance indicate a significant difference in behavior between vertically and horizontally grown ingots. Horizontal ingots generally make diodes which behave as expected in Day's model of traps uniformly distributed throughout a diode with a uniform collection field. Diodes made from vertical ingots, however, have a very large and unexpected dependence of the trapping on the applied bias which indicates the existence of yet another tailing mechanism. IR diode response studies have been performed which indicate a band of energies lying 0.05–0.22 eV from one band edge. The strength of this band is in direct correlation with the diode performance. This gives better understanding of the trapping phenomena and provides a quick, easy test for evaluating the material. Diode reverse current and lifetime versus temperature measurements on the diodes have substantiated the results of the IR response. Reverse current measurements, which are most sensitive to deep levels, indicate levels at ~0.5 eV from the opposite band edge. (Note: 0.72–0.22 eV = 0.5 eV.) Lifetime measurements indicate recombination centers at 0.14–0.18 eV and trap centers at 0.03–0.05 eV. IR absorption measurements indicate the presence of thermal defects in all vertically grown material and heat treated (860°C) horizontally grown material. These defects are tentatively identified as a vacancy at 0.25 eV and a mass defect (as may be caused by neutron bombardment) at 0.31 eV. Rapid lithium precipitation is presumed to occur near these defects, thus preventing accurate lithium compensation in selected regions. This non compensation results in weak collection fields and is the reason for the unexpected tailing characteristics of diodes made from vertical ingots. The band of energies from 0.05–0.22 eV is the source of trapping in Ge(Li) detectors. There is strong evidence that this band is the result of highly insoluble precipitated impurities. In general, the impurity problem is significantly less in vertically grown crystals as compared to horizontally grown crystals. On this basis, vertical crystals should make better detectors. However, there appears to be a thermal defect problem in vertically grown material which makes uniform exact compensation impossible so that very high biases are necessary for good charge collection from the weak field regions. (auth)

13994 POSSIBILITY OF SEMICONDUCTOR α-SPECTROMETER UTILIZATION FOR THE INVESTIGATION OF THE THICKNESS DISTRIBUTION OF α-ACTIVE ELEMENTS IN A THIN LAYER WITHOUT THE LAYER DISTORTION. Polevoi, R. M.; Rodionov, Yu. F. Zh. Tekh. Fiz., 38: 1178-80(July 1968). (In Russian).

The feasibility of using a semiconductor alpha particle spectrometer for the study of diffusion of alpha emitters into materials with a thickness ranging from 3×10^{-2} microns to that equal to the mean-free-path of the alpha particles has been established. Changes in the spectra of particles transmitted through a series of foil thicknesses relative to the source spectra determine the sensitivity of the method. The sensitivity also depends on the spectrometer resolution, which for silicon detector spectrographs indicates depth resolution of 2.7×10^{-2} microns. This method is also applicable for measurement of auto-diffusion and of inverse processes such as rates of depletion due to temperature or irradiation effects. In the latter cases the resolving depth is smaller (about 0.5 microns). (ATD)

13995 RADIO-ACTIVITY MEASUREMENT SYSTEMS. (to Ans, Inc.). British Patent 1,142,483. Feb. 5, 1969. Priority date Mar. 18, 1965, United States.

A liquid scintillation spectrometer system for alpha, beta, and gamma radiation is described. (B.G.D.)

13996 IMPROVEMENTS IN OR RELATING TO CIRCUIT ARRANGEMENTS INCLUDING PHOTOMULTIPLIER TUBES. (to Philips Electronic and Associated Industries Ltd.). British Patent 1,141,424. Jan. 29, 1969. Priority date Feb. 8, 1966, Austria.

A circuit arrangement, suitable for low-level scintillation counting where discrimination is necessary against noise, is described comprising a photomultiplier tube consisting of a photocathode, a first dynode, an electron lens system between the photocathode and the first dynode, and an anode electrode. The photocathode, the first dynode and the lens system are arranged together to give rise to a systematic spread in the times of flight between the photocathode and the first dynode for electrons originating from different positions on the photocathode in operation. A counter is arranged to count only those pulses arising at the anode whose distribution in time indicates that they arise from the simultaneous emission of more than one electron from the photocathode. (UK)

13997 CHARGED PARTICLES ANALYZING DEVICE. Hashimoto, Hiroshi (to Hitachi Ltd.). Japanese Patent 1968-24158. Oct. 11, 1968. Filed Nov. 27, 1964.

The method proposed is applicable for a neutron spectrometer, a Compton spectrometer, etc., which uses as a radiation source a n-p or x-ray converter. The advantage is an easy replacement of the converter. A converter is set on the bottom of a chamber. The chamber is fixed on its open end to the particle window. The window itself is fixed to the body, so as to be detachable. (NSA of Japan)

13998 THIN WINDOW DRIFTED SILICON, CHARGED PARTICLE DETECTOR. Fessler, Theodore E.; Smith, Albert B.; Vincent, John S. (to Administrator of the National Aeronautics and Space Administration). U. S. Patent 3,421,056. Jan. 7, 1969. Filed Dec. 20, 1966.

A thick junction radiation detector, comprising: a silicon body having an n-type material and a p-type material exactly compensated throughout to provide an intrinsic silicon and a thin layer of rectifying contact material coating the intrinsic silicon body to provide a radiation detector having uniform energy resolution, is described. (U.S. Pat. Gazette)

13999 ENERGY DEPENDENCE OF LIGHT OUTPUT OF ZnS(Ag) PHOSPHORS. Arsaev, M. I.; Belov, O. Kh. At. Energ. (USSR), 26: 24-7(Jan. 1969). (In Russian).

Energy dependence of the relative conversion efficiency of ZnS(Ag) phosphors under excitation with Roentgen rays in the range of quantum effective energy from 10 to 125 keV and also an α/γ ratio in this energy range of γ-quanta (the energy of α-particles E_α is 5.487 MeV) are studied. Phosphors of two types (trade marks ΦC-4 and K-430) are investigated. It is found that the conversion efficiency in the above energy range of Roentgen-quanta is constant within the error limits. The conversion efficiency of the ΦC-4 phosphor is 1.35 of that of the K-430 one. The α/γ-ratios of mentioned phosphors are respectively: $(\alpha/\gamma)_{\Phi C\text{-}4} = 1.9$, $(\alpha/\gamma)_{K\text{-}430} = 2.7$. (auth)

14000 MOBILE TELESCOPE FOR EXAMINING VERTICAL INTENSITY OF COSMIC RAY FLUXES. MacGregor, G. Allen; D'Arcy, Raymond G. (Univ. of California, Livermore). Rev. Sci. Instrum., 40: 237-41(Feb. 1969).

The mechanical and electrical features of a mobile scintillator-photomultiplier cosmic ray telescope are described. The telescope has been used on frequent occasions to obtain cosmic ray equator points and to examine the vertical cosmic ray intensity at atmospheric depths of 200 to 250 g/cm^2. Statistical errors in the total counting rates were less than 1% and overall experimental errors totaled less than 2%. (auth)

14001 PULSE RISETIMES IN PROPORTIONAL COUNTERS. Ricker, G. R. Jr.; Gomes, J. J. (Massachusetts Inst. of Tech., Cambridge). Contract NAS 5-11082. Rev. Sci. Instrum., 40: 227-32(Feb. 1969).

A method of calculating proportional counter pulse shapes for both point and extended ionization tracks is presented. The method is applicable to any counter gas for which the electron drift velocity as a function of the electric field is known. The mobility of the positive ions that are responsible for pulse formation is a parameter of the theory. If it is assumed that there is only one species of positive charge carrier, it can be identified by measuring counter pulse shapes for point ionization tracks and comparing them to calculated pulse shapes. The theory is consistent with measurements of actual pulses in four counter gases: 90% Ar–10% CH_4, 90% Ar–10% N_2, 90% Kr–10% CO_2, and 90% Xe–10% CO_2. (auth)

14002 ELIMINATION OF PHOTOMULTIPLIER GAIN SHIFT DUE TO EXTRANEOUS WEAK REVERSIBLE MAGNETIC FIELD. Palathingal, J. C. (Univ. of Cincinnati). Rev. Sci. Instrum., 40: 266-7(Feb. 1969).

In measurements of circular polarization of gamma rays in which the radiation is detected by a scintillator coupled to a photomultiplier, the phototube has to be shielded from the reversible fringing magnetic field of the polarization analyzer. Weak residual fields, however, produce a small gain shift between the photomultiplier outputs during the periods of opposite magnetizations of the polarimeter. By applying slightly different voltages to the photomultiplier simultaneously with reversals of the magnetic field, this shift can be eliminated. A simple effective method of utilizing this suggestion is outlined. (auth)

14003 A GEIGER–MUELLER COUNTER FOR ULTRAHIGH VACUUM SYSTEMS. Klier, K. (Lehigh Univ., Bethlehem, Pa.). Rev. Sci. Instrum., 40: 372-4(Feb. 1969).

A Geiger–Mueller counter is described which has a 25% efficiency for ^{14}C beta particles (0.16 MeV), is bakable, and has been used in uhv systems with ultimate pressures below 1×10^{-10} Torr. (B.G.D.)

14004 PANORAMIC RADIATION DETECTOR HAVING A MULTIPLICITY OF ISOLATED GAS CHAMBERS. Spergel, Philip; Di Rocco, James V.; Grenier, Raymond P. (to Baird-Atomic, Inc.). U. S. Patent 3,418,474. Dec. 24, 1968. Filed Nov. 9, 1965.

A radiation detector array is provided with a multiplicity of identical, substantially isolated, minute chambers, each having an electrically conducting wall and an electrically conducting pin, the chambers communicating with each other through ports and containing an ionizable gas, a readout matrix being associated with the pins to indicate any pin of the plurality which conducts as a result of radiation incident to its chamber. (U. S. Pat. Gazette)

14005 MINIMUM IONIZATION PARTICLE DETECTOR PRODUCED BY GAMMA RAY IRRADIATION. Blumenfeld, H. A.; Pandolfi, F. P.; Sun, Chih-ree (to United States Atomic Energy Commission). U. S. Patent 3,430,043. Feb. 25, 1969.

A charged particle detector of silicon that is irradiated with gamma rays and biased during the irradiation for measuring the change in the resistivity of the silicon thereby to produce uniform, homogeneously located, crystal defects throughout the silicon, is described. (AEC)

14006 DETERMINATION OF DETECTION EFFICIENCIES OF NaI SCINTILLATION DETECTORS FOR GAMMA-RAY SOURCES DISTRIBUTED IN WATER. Moriuchi, Shigeru; Matsushita, Kozo (Japan Atomic Energy Research Inst., Ibaraki). (In Japanese).

Measurements for determining detection efficiencies of three NaI scintillators having dimensions of 1 in. $\phi \times 1$ in. to 2 in. $\phi \times 2$ in. were made for various gamma-ray sources distributed uniformly in water tanks. Gamma-ray energies are ranged between 0.13 MeV and 1.84 MeV, and water tanks are cylindrical ones having the diameter equal to the depth. Results were expressed by approximation formulae as a function of radii of volume-equivalent spherical water tanks, and the responses in infinite water volume were extrapolated. Counting efficiencies for a unit gamma emitter per unit volume can be calculated by this equation with reproducing errors of ±5%. The energy response was fairly flat over a wide energy range with a small tank of about 20 cm in radius, independent of the size of scintillator. Furthermore, photon number buildup factors were derived from the formula and compared with those calculated from energy buildup factors given by Goldstein, et al. The values obtained experimentally were about one half of Goldstein's. This fact implies that it would cause big errors in the determination of counting efficiencies of gamma detectors to use the buildup factors for photon numbers calculated from those for energy or dose. (auth)

14007 A TRIAL PRODUCTION OF PLUTONIUM CONTAMINATED WOUND COUNTERS. Yamaoka, Y.; Kuroda, H.; Tatsuta, H. (Japan Atomic Energy Research Inst., Tokai). pp 1003-9 of Radiation Protection. Part 2. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

A rapid increase of the amount of plutonium to be handled in our Institute has accelerated the need for preparation of wound counters capable of detecting at least a fraction of MPBB (40 nCi) in a plutonium contaminated wound. Two kinds of wound counters, a xenon gas-filled proportional counter and a cesium iodide crystal scintillation counter, were constructed and their characteristics were examined. The minimum detectable amount for the former was 5.5 nCi and that for the latter was 0.83 nCi when the plutonium was imbedded 6 mm under tissue and the window of the detector was positioned at 3 mm above the skin surface. In order to determine the location of plutonium, a 0.1-mm-thick lead plate and a lead-impregnated flexible material were prepared. The method of determination of the effective depth of contaminants is discussed mainly for the cases of pure plutonium and plutonium with an unknown content of americium in the wound. Furthermore, we have shown that the depth distribution of the contaminants can be obtained in fairly good agreement with the actual distribution by the method of expansion of source distribution using the orthonormal function series method. This method will be valid provided the contaminant lies continuously in the wound. (auth)

14008 DETECTION OF IONIZING PARTICLES AND FAST NEUTRONS BY SCINTILLATION IN HELIUM OR ARGON UNDER HIGH PRESSURE. Blanc, Daniel; Galy, Jacques; Teyssier, Jean-Louis (Faculte des Sciences, Toulouse). pp 1011-20 of Radiation Protection. Part 2. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968. (In French).

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.2)).

In order to detect fast neutrons with the aid of a gaseous scintillator, it is necessary to fill them under a pressure of several tens of atmospheres. This type of detector was studied. Helium or argon containing respectively 5 and 10 ppm of nitrogen, 5 and 3 ppm of oxygen, and 1 ppm of water vapor was used. The intensity of the fluorescence of the helium irradiated by α particles from ^{210}Po decreased when the pressure passes from 6 to 40 atm. The addition of nitrogen in controlled quantity (maximum concentration of 10%) shows that this decrease does not depend on the quantity of nitrogen introduced. This justifies the decrease observed when the impurities are present in the state of traces. An identical phenomenon is produced in argon. In order to collect sufficiently the light with a filling under high pressure, a long-wave converter, sodium salicylate, is used. This degases little and the response of the detector is stable with time. In these conditions the intensity of the fluorescence of the argon remains constant between 2 and 7 atm. When nitrogen is added, both to helium and to argon, the intensity of the light emitted decreases. When the pressure is increased, the curves obtained for the different concentrations are parallel. For 14-MeV neutrons, obtained by (d,t) reaction, the helium is simultaneously the target and the scintillator. These are detected with the aid of helium recoil nuclei produced by elastic scattering. The energy spectrum of the recoil nuclei were traced. The corrections for boundary effect and energy resolution were determined; these are necessary in order to obtain the values of the elastic scattering differential cross section. (tr-auth)

14009 CORRECTION FOR WALL THICKNESS OF AN IONIZATION CHAMBER IN GAMMA RADIATION MEASUREMENTS. Klumpar, Josef; Majerova, Miroslava; Jirousek, Pavel (Inst. of Nuclear Research, Prague). Jad. Energ., 15: 53-4(1969). (In Czech).

Experimental values of correction coefficients for the absorption of the primary photons in the walls of ionization chambers are given. The mean value for ^{60}Co-gamma radiation derived from 9 absorption curves is equal to 3.2 ± 0.3% for a wall thickness of 1 g/cm^2. (auth)

14010 γ CAMERAS DEVELOPED IN JAPAN. NUCLEAR IMAGE TUBE CAMERA AND MULTISTAGE IMAGE TUBE γ CAMERA. Ueda, Hideo; Sasaki, Yasuhito (Tokyo Univ.). Radioisotopes (Tokyo), 17: 321-7(July 1968). (In Japanese).

In order to utilize an excellent γ-camera at low price, the Ter-Poggossian type nuclear image tube camera and the multistage image tube γ-camera are being developed. Although these cameras are under development they are being used in clinical applications. Nuclear image tube camera: x rays or γ-rays from radiation sources are collected with the multihole collimator and photons colliding with the input phosphor screen of the image tube are changed to an optical figure which is changed into an electronic image by a photoelectric screen. The electron beam produced is collected, accelerated to make a small image with high energy on the output phosphor screen in the image tube. This image was photographed on a polaroid film of ASA 3,000–10,000. The sensitivity using a two stage image tube is ten times as high as that of one stage. The time required is approximately 5 minutes, $\frac{1}{3}-\frac{1}{8}$ of the time required for usual liver scanning. Multistage image tube γ-camera: the γ-ray from a subject enters a NaI scintillation crystal or ZnS fluorescent plate through a parallel collimator and forms a radiant distribution in agreement with the radioisotope distribution of the subject. When radiant distribution throws an image with an optical lens on the input photoelectric screen of the multistage image tube, the photoelectrons are generated in accordance with brightness and it is accelerated strongly with the secondary electron acceleration film and reproduces a bright image on the output phosphor screen which is recorded with a polaroid camera, a television or a video tape system. These two cameras are cheaper than existing foreign cameras and compare quite well with them though they have been just developed and have to be improved more. (NSA of Japan)

14011 MONOENERGETIC NEUTRONS OF INTERMEDIATE ENERGY: A CALIBRATION FACILITY DESIGN. Anderson, Lowell L. (Argonne National Lab., Ill.). Health Phys., 16: 359-69(Mar. 1969).

A resonance-scattering facility was designed for use at the Argonne CP-5 reactor in the calibration of radiation-safety neutron instruments at intermediate energies, for which monoenergetic sources are not available. The source consists of neutrons scattered isotropically, at the energy of a primary resonance, by a thin foil placed in a vertical beam from the

reactor. Unwanted scattering at other energies will be minimized by a difference method employing a beam filter of the same material as the target. Target nuclides were identified which would provide from three to five discrete source energies per logarithmic decade throughout the intermediate energy region. Source intensities, expected to range from 10^6 to 10^7 n/sec, will be measured absolutely using a manganese bath technique. Detectors to be calibrated will be supported at target level by a track-mounted frame, in order to facilitate inverse square measurements for a room-scattering correction. Accurate background subtraction may require frequent repetition of a four-count cycle based on inserted and withdrawn positions of target and filter. (auth) (UK)

14012 SENSITIVE METHOD FOR ROUTINE DAILY LEAK TESTING RADIUM SOURCES USING AN ION CHAMBER TO DETECT RADON. Waters, John R. (Johnston Labs., Inc., Baltimore). Health Phys., 16: 379-82(Mar. 1969).

A simple test for leaky radium sources is described. The escaping radon gas is detected in a gamma compensated ion chamber system, a small air pump being used to force the gas through the chamber. This test is compared with other tests, in particular, one that detects the alpha emission from radon daughters deposited on the lid of a small jar after the radium source is sealed for 24 hr. Two leaky radium sources, one gross leaker and one with an extremely small leak, were tested by both methods. The radon test was more sensitive in that it gave a better signal-to-noise ratio. It is estimated that 500 pCi of radon were detected from the slow leaker, giving a signal-to-background ratio of 49. It is thought that 50 pCi could be readily detected, making this a very sensitive test. A simplified, inexpensive test instrument could be incorporated into radium safes and actuated every 12 hr to give a fast warning of source leakage. (auth) (UK)

14013 SEMICONDUCTOR NUCLEAR PARTICLE DETECTORS. Dance, J. B. Instrum. Pract., 23: 113-16(Feb. 1969).

Semiconductor nuclear particle detectors quickly found applications in nuclear physics laboratories and are being widely used in industry, research and medicine whenever they offer advantages for the particular applications concerned. After a short introduction, a description is given of some of the most common applications of these devices. (auth) (UK)

14014 A SENSITIVE GEIGER–MUELLER DETECTOR READING FLUX AND DOSE RATE DIRECTLY. Ozair, V.; Andrews, D. G. (Univ. of Toronto). Nucl. Appl., 6: 225-31(Mar. 1969).

The development of an efficient gamma radiation detector that reads directly in flux and dose rate has been partially successful. The efficiency of the normal Geiger-Mueller counter is known to fall to a minimum in the region where high efficiency is most often needed, namely in the middle of the Compton scatter region. The interaction probability rises on the low-energy side, due to increasing photo-electric absorption, and on the high-energy side, due to increasing pair-production. In the present work, the response to photo-electric and Compton electrons has been increased substantially by using a mesh cathode instead of a solid-walled cathode, together with an appropriate gas filling and an enlarged anode. Characteristics are adjusted by use of a sliding sleeve. (auth)

14015 PORTABLE BETA–GAMMA FOOT MONITOR (Engineering Materials). (Los Alamos Scientific Lab., N. Mex.). (CAPE–1823).

4 drawings.

An economical, portable, and reliable foot monitor which can be used with existing survey instruments is described. The monitor contains two G–M tubes. Each tube is located in a compartment lined on two sides with lead to reduce background radiation. The foot monitor requires a minimum of maintenance. (For details see TID-4100 Suppl. 50) (F.S.)

14016 CONSTRUCTION OF A GERMANIUM P-I-N DETECTOR. Nagahara, Teruaki (Rikkyo Univ., Tokyo); Ishizuka, Yasuhiro. Bunseki Kiki, 6: 707-15(Nov. 1968). (In Japanese).

Procedures for fabricating a germanium p–i–n detector are described. The selection and processing of germanium and the lithium-drifting process are discussed. Voltage and current characteristics, capacity of the detector, energy resolution, and detection efficiency are also discussed. (TSS) (NSA of Japan)

14017 EFFICIENCY AND REACTION RATE OF THE RADIATION DETECTORS. Kato, Ryuhei (Ritumeikan Univ., Kyoto). Ritsumeikan Daigaku Rikogaku Kenkyusho Kiyo, No. 17, 24-9 (Dec. 1968). (In Japanese).

When a high reliability of the nuclear particle detector, for example neutron detector, is required, it is necessary that only a vanishingly small fraction of the incident particles which passes through the chamber are absorbed. This condition ensures that the detector does not disturb the incident beam. The absorption of particles upon passage through the counter lowers the beam at the counter, since these particles are not available for counting. When such absorption is high, a proper correction for counting is needed. A method for the correction is shown. The efficiency of a neutron detector depends also on the size and shape of the counter and on the direction of the neutrons. Calculations and experimental measurements are compared. Moreover, the theory for absorption and efficiency of a detector is applicable to radiation damage and biological radiation effects. (NSA of Japan)

14018 UNIVERSAL SCINTISCANNER. Kashiwazaki, Masaaki; Kurihara, Shigeyasu; Sano, Terusato; Kumano, Nobuo (Tokyo Shibaura Electric Co., Ltd.). Toshiba Rev., Int. Ed., No. 39, 30-6(Nov.-Dec. 1968).

A universal scintiscanner with two detectors has been successfully developed. With a unique mechanism introduced for the suspension of a 5 in. $\phi \times 2$ in. large detector, high-speed scanning with stability is assured. It is provided with two units each of measuring system and recording system. This apparatus is capable of isosensitive scanning, laminoscanning and double-tracer scanning, as well as common area scanning, and is found suitable for multiple diagnostic purposes. (auth)

14019 MINIATURE NEUTRON DETECTOR (Engineering Materials). (Sandia Lab., Albuquerque, N. Mex.). (CAPE–1824).

39 drawing.

A miniature neutron detector used to test the operation of a pulsed 14 MeV neutron generator is described. The detector consists of a plastic scintillator which converts neutron energy to light; a photomultiplier tube which collects light and converts it into an amplified electric signal; a power supply which is adjustable between -750 and -1300 V; and electronic signal-conditioning circuitry which produces an output when the neutron level exceeds a prescribed value. The entire detector weighs less than one pound. (For details see TID-4100 Suppl. 50). (F.S.)

14020 GEIGER–MUELLER COUNTER FOR THE DETECTION OF EXO-ELECTRONS. Momose, Yoshihiro; Tamai, Yasukatsu (Tohoku Univ., Sendai). Tohoku Daigaku Hisuiyoeki Kagaku Kenkyusho Hokoku, 17: 435-41(July 1968). (In Japanese).

When metallic or non-metallic compounds are treated by such methods as machining, irradiation with electrons, x-rays or ultra-violet rays, phase transformation, electric discharge in gas, etc., exo-electrons are irradiated even at low temperatures. This phenomenon is the Kramer effect. The measurement of exo-electrons is an effective method for determining the activity of a stimulated surface. The measuring method of exo-electrons with the Geiger-Mueller counter and the construction of the manufactured counter are explained. The material for the anode and the cathode is tungsten filament, and the size of the counter is determined according to sizes of samples. The grid of 30 mesh brass gauze is attached on the cathode, and the soldering iron heater is placed between two metallic plates mounted on a quartz base and used for the sample support. The counter is vacuum pumped after a sample is placed in it, washed with argon gas, and filled with ethanol and argon in that order. (NSA of Japan)

14021 PROCESS AND DETECTOR FOR INDICATING THE TRACKS OF ALPHA PARTICLES USING STACKED LAYERS OF MATERIAL. Evans, Robley D. U. S. Patent 3,418,472. Dec. 24, 1968. Filed Apr. 4, 1966.

Stacked layers of materials such as plastics are used for indicating the tracks of α particles. Each layer of material has the thickness comparable with the effective etching depth of the material. After irradiation, the layers may be separated and separately etched, enabling α tracks to be detected that would otherwise be undetectable in solid media of the same thickness as the stack of layers. Materials suitable for use include cellulose nitrate, cellulose acetate, and cellulose acetate butyrate. (F.S.)

Nuclear Spectroscopic Instrumentation

14022 (CEA-CONF-1200) RESEARCH AND DEVELOPMENT OF A MULTIMODE γ SPECTROMETER. Haouat, G.; Lachkar, J.; Sigaud, J. (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes). [nd]. 7p. (In French). (CONF-681208-6). Dep.

From Conference on Experimental Methods in Nuclear and Particle Physics, Strasbourg, France.

A multimode gamma ray spectrometer, which permits the separate and simultaneous detection of photons according to three modes: total absorption, photoelectric, and anti-Compton effects, is described. The spectrometer consists of a central

Ge(Li) detector and of a large NaI annulus split in four optically separated sectors. (auth)

14023 (CEA-CONF-1228) POSITION SENSITIVE DETECTORS ASSOCIATED WITH A BUECHNER SPECTROMETER. Lemarchand, G.; Quidort, J. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). [nd]. 7p. (In French). (CONF-681208-9). Dep.

From Conference on Experimental Methods in Nuclear and Particle Physics, Strasbourg, France.

A particle detector system for the Saclay's Buechner spectrometer is described. It includes four position-sensitive detectors (active area 50 × 15 mm) connected to a pulse voltage dividing circuit. The space resolution is 0.7 mm and the nonlinearity position is less than 5%. (auth)

14024 (SZS-13/68) RAPID IDENTIFICATION OF β-EMITTING NUCLIDES BY MEANS OF β SCINTILLATION SPECTROMETRY. Loessner, V. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany). June 1968. 54p. (In German). Dep.

The application of CsI(Tl) as a scintillator for β-spectrometry was studied, with special attention to the analysis of complex β-spectra. Comparative investigations of CsI(Tl), CsI(Na), and NaI(Tl) showed that CsI(Tl) has more favorable properties than the others for a fast identification of β-emitting nuclides. At best conditions it is possible to separate five β-components. (auth)

14025 EFFICIENCY DETERMINATION OF SCINTILLATION γ-SPECTROMETER. Lapenas, A. A.; Baltmugur, K. K. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser., No. 6, 37-9(1968). (In Russian).

Photoefficiency on the solid angle of the scintillation γ-spectrometer has been determined by means of the $4\pi\beta$-γ coincidence method. The spectrometer consists of a photomultiplier with NaI(Tl) crystals the dimensions being: 39.5 × 49.5; 59 × 60 and 39 × 39 mm, and the values of h = 32; h = 50; h = 87 mm between the γ-quantum source and the crystal. (auth)

14026 IMPROVEMENT IN THE LUMINOSITY OF A DUMOND TYPE β-RAY SPECTROMETER. I. Hiromura, Kazuyuki; Mitamura Tohru (Himeji Inst. of Tech., Japan). Himeji Kogyo Daigaku Kenkyu Hokoku, 21A: 9-14(Oct. 1968). (In Japanese).

A method is discussed to increase the luminosity of a DuMond type uniform magnetic field β-ray spectrometer by using electrostatic correctors. The shape of the corrector for spherical aberration is determined from the calculation of the radial aberration for the combined electrostatic-magnetic system. The multisource consisting of a number of disk sources placed along the spectrometer axis is also employed together with the correcting potentials varying with the axial position of each source. Using these methods it is possible to increase the luminosity of the spectrometer by about a factor of 50 at a resolution of about 0.3%. (auth) (NSA of Japan)

14027 INTERMOLECULAR INTERACTION OF EXCITED STATES IN CRYSTALS AND LIQUIDS. Goldschmidt, C. R.; Tomkiewicz, Y.; Berlman, I. B. (Hebrew Univ., Jerusalem). Chem. Phys. Lett., 2: 520-2(Dec. 1968).

Experimental evidence is presented on an excimer–excimer interaction in pyrene crystals and solutions containing a high concentration of pyrene. This interaction is used to explain in part why scintillation pulse shapes when excited by α particles contain less of an excimer component than when excited by β particles. (auth)

14028 A COMPREHENSIVE SYSTEM FOR COMPUTER GAIN CHANGING OF SCINTILLATION SPECTRA. Steyn, J. J. (NUS Corp., Rockville, Md.); Andrews, D. G. Nucl. Sci. Eng., 35: 399-401(Mar. 1969).

A comprehensive gain-changing computer code, identified as GANE is described. It was developed during the course of experimental research into gamma photon backscattering, as an aid in the computer analysis of spectra, and has been subsequently improved. It is designed primarily around a sequence of logical steps, that is, an algorithm. It has been extensively tested over the past four years in a variety of applications and has been found to be accurate, versatile, and computer time-saving. (auth)

14029 NEW PRINCIPLE IN DESIGNING X- AND GAMMA SPECTROMETERS. Nikol'skii, A. P. Prib. Sist. Upr., No. 4, 42-3(1968). (In Russian).

A description is given of a spectrometer in which the focusing of the x- or gamma-radiation is based on a reverse piezoelectric effect. The reverse piezoeffect consists in the generation of deformations when the crystal is placed in an electric field. Evidently, the crystal deformations cause a change in the interplanar distances and, consequently, a change in the focusing conditions of the investigated radiation. In this spectrometer with a stationary crystal it is possible to focus the instrument for different wave lengths. The advantage of the piezoelectric focusing method is the ease with which focusing can be controlled which is characteristic of electrostatic systems. Its disadvantage consists in the absence of crystal-piezoelectrics which permit the focusing conditions to be varied over a wide range of wavelengths. Piezoelectric focusing in modern spectrometers can be used for studying fine structures of spectra over a small range of angles. Further development of crystal physics and the processing of crystals with large piezoelectric constants will permit the conversion of this method into one of the fundamental methods of x- and gamma-radiation focusing. (ATD)

14030 PDP-8-NEUTRON SPECTROMETER INTERFACE (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1825).

13 drawings.

An interface is described which is used with a triple-axis neutron spectrometer which is to be controlled by a PDP-8 computer. Up to 8 Slo-Syn stepping motors can be positioned. The count rates of the primary neutron beam (before it passes through the monochromator), the incident beam (after it passes through the monochromator), and the diffracted neutron beam are measured, and the adjusted intensity measurements of the diffracted beam are recorded as a histogram plot. (For details see TID-4100 Suppl. 50) (see also 22: 49097). (F.S.)

14031 MAGNETIC UMB-TYPE BETA SPECTROMETERS. Gumenyuk, B. A.; Granberg, G. L.; Ivanova, G. D.; Peregud, B. P.; Cherstvov, L. A. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekh. Fiz., 38: 539-49(Mar. 1968). (In Russian).

The construction and comparative characteristics of the universal magnetic beta spectrometer UMB-1 and its recent modifications (UMB-1M, UMB-2) are described. The maximum resolution of UMB-1, obtained at source and receiving-slit dimensions 12 × 0.4 mm is 0.014%, and the solid angle is 0.02% of 4π. The maximum possible solid angle is 0.7% at a resolution of 0.2% and at source dimensions 15 × 1 mm. The capabilities of this spectrometer, whose electron-optical system is similar to that of an optical spectrometer, can be greatly increased by using collimating focusing lenses with variable field distribution. The spectrometer UMB-1M has a resolution of 0.014+ at the same aperture and source dimensions as UMB-1, but at the maximum solid angle, 2% of 4π, its resolution is 0.6% for source and slit dimensions 15 × 1 mm. The UMB-2 spectrometer uses a lens with variable field distribution, and the luminosity is increased by placing in the focal plane of the collimator several sources parallel to each other, each having a definite potential relative to the housing of the instrument. The potentials are chosen such that the electron-optical images of all the sources coincide in the focal plane of the focusing lens. It is concluded from the comparison that the UMB-2 spectrometer is superior, at very high resolutions 0.01% to 0.2%, to all the presently known similar instruments. (ATD)

High Energy Physics Instrumentation

Refer also to abstract 14940.

14032 (BNL-13189) TEN EXPERIMENT PERSPECTIVE VIEW OF AN ANALYSIS SYSTEM USING ROAD-GUIDANCE FSD'S. Abrams, K. L.; Connolly, P. L.; Crennell, K. M.; (and others) (Brookhaven National Lab., Upton, N. Y.). [1967]. 14p. (CONF-681025-8). Dep. CFSTI.

From International Conference on Advanced Data Processing for Bubble and Spark Chambers, Argonne, Ill.

An attempt is made to characterize the behavior and performance of an analysis system using road-guidance flying spot digitizers, based on completed bubble chamber experiments on π, K, and p interactions with protons. (L.B.S.)

14033 (CEA-CONF-1152) WIRE SPARK CHAMBER WITH A CORE MEMORY OF LARGE SIZE. Boucherie, A.; Garcia, J.; Mougel, J. F. ([Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires]). [1968]. 12p. (In French). (CONF-680906-9). Dep.

From International Symposium on Nuclear Electronics, Versailles, France.

A system including a wire spark chamber with core memory is described, and the choice of the definitive structure and the logical apparatus for analysis and data transfer are discussed. The realizations from this study are briefly described. (auth)

14034 TV METHOD OF GETTING INFORMATION FROM SPARK CHAMBER WITH MANY GAPS. Podlaskin, B. G.; Sumachev, V. V. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekh. Fiz., 38: 1169-77(July 1968). (In Russian).

The application of a television display for recording of information generated in a spark chamber with a large number of gaps is described. This method is selected as the most suitable for automation of nuclear physics experiments since it combines the advantages of photographic films and contains sequential trains of pulses that can be fed into a computer, thus permitting real-time experiment control. The above is used as the basic requirement in the analysis of a system which is designed for proton polarization experiments where proton energies are 200–500 MeV and the beam intensity produces up to 10 collisions per second. The analysis shows that control of the ampere-turns of the magnetic lens provides a different scanning signature for lines and points. Such differentiation was built into the television system which then was tested with cosmic μ-mesons. The incomplete system effectiveness and variation of the spark brightness resulted in some information loss, which can be corrected by increasing spark brightness. (ATD)

14035 MODIFICATION OF MULTIPLE SCATTERING THEORY IN VIEW OF RECENT HIGH CELL-SIZE MEASUREMENTS. Agnese, A.; Paoli, G.; Scotto, M.; Wataghin, A. (Univ., Genoa. Istituto Nazionale di Fisica Nucleare, Genoa). Acta Phys. Acad. Sci. Hung., 25: 71-81(1968).

A reformulation of the Voivodic–Pickup formulation of the scattering theory is presented. Modifications are introduced for the correct introduction of the finite size limit and also for the treatment of inhomogeneous materials. Agreement with the experimental data for nuclear emulsions at high cell sizes is clearly better with the reformulated version than with the old version. (auth)

14036 SPARK AND STREAMER CHAMBERS. Rice-Evans, P. (Bedford Coll., London). J. Phys., E (London), 2: 221-9 (Mar. 1969).

The operation of the basic multiplate spark chamber is described, and the evolution of the wide-gap spark chamber and the streamer chamber is discussed. Some attention is paid to the spark mechanism in noble gases, and also to the recording systems that have been used in conjunction with narrow-gap chambers. (auth) (UK)

14037 HIGH PRESSURE GAS DIFFERENTIAL COUNTER (Engineering Materials). (Rochester Univ., N. Y.). (CAPE–1828).

43 drawings.

A high pressure gas differential Cherenkov counter designed for use at the 130 in. cyclotron is described. The counter is fabricated of forged steel pipe fittings. The diameter of the radiator is 5 in. Carbon dioxide at 2500 psi is employed for operation at 110°F. (For details see TID-4100 Suppl. 50) (See also NSA 23: 2561) (F.S.)

14038 BROOKHAVEN NATIONAL LABORATORY BUILDS STRONGEST LARGE MAGNET. Van Tilburg, Gerald (American Metal Climax, Inc., New York). Cryog. Eng. News, 4: No. 2, 14-17(Feb. 1969).

BNL is constructing a 7-ft diameter bubble chamber test facility with a 9-ft diameter superconducting magnet. This facility will aid investigations of design concepts for a 14-ft bubble chamber with a 16-ft superconducting magnet. The magnet combines approximately 32,000 lb of OFHC copper with the niobium–titanium superconductor to form a composite conductor capable of carrying 6000 A in a stabilized mode. At this current, the magnet will generate a central magnetic field intensity of 30 kG. A brief description of the magnet design is presented. (W.H.K.)

14039 CHARACTERISTICS OF AUTOMATIC PARTICLE-TRACK ANALYZER CAMP AND ITS FUTURE. Takahashi, Masaaki. Erekutoronikusu, 13: 1342-7(Nov. 1968). (In Japanese).

The CAMP (computer aided measuring projector) was developed in the Univ. of Tokyo, Institute for Nuclear Study. It aims at automatic, rapid, and accurate measurement by means of on-line computer control. The CAMP includes the following: a light source, main and auxiliary optical systems, measuring stage and stage digitizer, stage vacuum attracting and blowing mechanism, film driving mechanism, events reader, tv system, rough digitizer, and prism and slit systems. By controlling the film driving mechanism, the film of measurement in the three channels is located at a position and projected on the screen. The image on a screen is generally by a main projection lens. In the midway, it is the side of a tv camera and the automatic reading system, by a mirror. The method of analysis is either automatic or manual. (NSA of Japan)

14040 LIQUID DIFFERENTIAL COUNTER (Engineering Materials). (Rochester Univ., N. Y.). (CAPE–1829).

12 drawings.

A liquid radiator differential Cherenkov counter is described. The liquid in the radiator is glycerine. The counter is fabricated of Al. One mirror, six 8575 photomultipliers and six Plexiglas light pipes are employed. No anticoincidence provision is available. The Cherenkov angle is 63°. (For details see TID-4100 Suppl. 50). (See also 23: 2561.) (F.S.)

14041 LOW PRESSURE GAS THRESHOLD COUNTERS (Engineering Materials). (Rochester Univ., N. Y.). (CAPE–1827).

30 drawings.

Three low pressure gas Cherenkov counters, 4-in., 12-in., and 42-in., are described. The 4-in. counter is 52 in. long and is fabricated of steel. Gaseous SF_6 is used at an operating pressure of 250 psi. The 12-in. counter is fabricated of rolled steel and is 87 in. long. The CO_2 gas operates at 200 psi. The 42-in. counter, which is 96 in. long, is fabricated of steel. The gas is SF_6 and is used at 250 psi. (For details see TID-4100 Suppl. 50) (see also 23: 2561). (F.S.)

14042 PHYSICAL CONDITIONS FOR CONTINUOUS SENSITIVITY OF LIQUID SOLUTIONS TO PARTICLE TRAVERSAL. Pisarev, A. F. (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksp. Teor. Fiz., 56: 370-9(Jan. 1969). (In Russian).

The possibility of creating in a binary liquid solution a region of continuous sensitivity to ions was analyzed thermodynamically. It was found that such a region exists in solutions with restricted solubility of the liquid components. In this region, particle tracks can be produced as a result of liberation of ions from the solution by surplus substances possessing a large dielectric constant. (auth)

14043 TRANSFER OF ^{137}Cs THROUGH PLACENTA AND MILK IN MICE. Matsusaka, Naonori; Inaba, Jiro; Ichikawa, Ryushi (National Inst. of Radiological Sciences, Chiba, Japan). Radioisotopes (Tokyo), 17: 584-7(Dec. 1968).

Quantitative information regarding transplacental and milk-borne ^{137}Cs in suckling mice, as well as the change, as a function of time, between the relative contributions of these two different pathways to the whole-body burden from birth to weaning is presented. When pregnant mice were given a single dose of ^{137}Cs one day before parturition, the ^{137}Cs body burden of the mice on the day of birth was about 0.8% of the activity administered to the dam. The transplacental ^{137}Cs in the suckling mice decreased with time until the 14th day and then it increased slightly until weaning. The contribution of milk-borne ^{137}Cs increased until the 14th day, after which time, it decreased slightly. It was suggested that the transplacental ^{137}Cs may make a somewhat larger contribution than milk-borne ^{137}Cs to the total body burden in the mouse from birth to weaning. (C.O.)

Radiation Dosimeters

Refer also to abstracts 13668 and 13974.

14044 (CEA-CONF-1068) DEVELOPMENT OF IONIZATION CHAMBERS DESIGNED TO MEASURE HEATING OF NUCLEAR ORIGIN. de Cosnac, B.; Fiche, C.; Lott, M.; Manent, G.; Noel, J. P. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). [nd]. 24p. (In French). (CONF-680302-7). Dep.

From International Symposium on Nuclear Electronics and Radioprotection, Toulouse, France.

Ionization chambers permit the measurement of nuclear heating in materials with sensitivities much greater than that of calorimetric methods. Some chambers were developed of different materials (Al, C, Fe, and CH_2) filled with different gases (air, CO_2, and C_2H_2) and with a volume varying from 1 cc to 1 m^3. The measurement of the current was done by means of a linear operational amplifier of 10^{-7} to 10^{-12} amp. It makes possible measurements with a linkage of 30 m of cable without a preamplifier. This apparatus is composed of a MOST (10^{15} Ω) transistor, protected against overcharges, associated with an integrated amplifier. The response of the chambers in mixed radiation fields was studied. (tr-auth)

14045 (EGG–1183-2166) MEGARAD DOSE RESPONSE OF PASSIVE DOSIMETRIC MATERIALS. Interim Report. Technical Report Number S-407-R. Kantz, A. D.; Humpherys, K. C.; Lucas, A. C.; Schlueter, W. A. (EG and G, Inc., Santa Barbara, Calif.). Oct. 12, 1967. 23p. Dep. CFSTI.

The responses of polyethylene, blue cellophane, radiachromic dyes, and cinemoids for megarad dosimetry in extreme environments are studied. Spectrophotometric analysis was used for dosimeter readout. (W.H.K.)

14046 (PAECL/HP-9) PAEC'S PERSONNEL MONITORING FILM-BADGE SERVICE AND THE DESIRABILITY OF PROVIDING

A SUPPLEMENTARY DOSIMETER. Mirza, Khalid Farooq; Malik, Walayat Khan (Atomic Energy Centre, Lahore (Pakistan). Health Physics Div.). Sept. 1968. 21p. Dep.

The results obtained during the last eight years of PAEC's Personnel Monitoring Film-Badge Service have been summed up. It is found that, on an average, each worker received a radiation dose of 36.4 milli-roentgen per week. It is also found that approximately 5 out of every 100 film-badges processed indicate over-exposures. A comparison is made of the characteristics of various dosimeters and it is suggested that a LiF thermoluminescent dosimeter should be accommodated in the film-badge holder in order to improve the quantitative determination of the radiation dose. (auth)

14047 DOSIMETRY. Barr, N. F. (Atomic Energy Commission, Washington D. C.). Nucl. News, 12: No. 2, 57-9(Feb. 1969).

The difficulties associated with direct measurement of the amount of energy absorbed by matter exposed to ionizing radiation are briefly discussed. Calorimetric techniques, chemical effects, and radiobiological effects are considered. (W.H.K.)

14048 METHOD OF MEASURING EMISSION SPECTRA FROM THERMOLUMINESCENT MATERIALS. McCall, Richard C.; Ross, Dennis K. (Stanford Linear Accelerator Center, Calif.). Rev. Sci. Instrum., 40: 363-4(Feb. 1969).

A method of measuring the emission spectra from at least a few thermoluminescent materials is described. The method provides an entrance window with a continuous supply of phosphor which has just reached some preselected temperature. The monochromator can then scan continuously at a suitable speed. (B.G.D.)

14049 TERMOLYUMINESTSENTNAYA DOZIMETRIYA. (Thermoluminescent Dosimetry). Shvarts, K. K.; Grant, Z. A.; Mezhs, T. K.; Grube, M. M. Riga, Izdatel'stvo Zinatne, 1968. 186p.

The physical principles of thermoluminescent dosimetry are presented. Different thermoluminescent dosimeters (TLD) being developed by industry and laboratories are described. The questions of measurement technology and applications of TLD dosimeters in different fields of applied dosimetry (personnel, radiology, radiobiology, etc.) are examined. Future prospects in the development of TLD dosimeters and for future applications in the measurement of larger doses (up to 1000 Mrads) are also discussed. A bibliography of 300 references on lithium fluoride thermoluminescent dosimeters for the period 1963–1968 is included. (tr-auth)

14050 HOLDER FOR RELEASABLY SECURING A SHAPE-RETAINING DOSIMETER ELEMENT DURING READOUT. Debye, Anne L.; Bjarngard, Bengt (to Isotopes, Inc.). U. S. Patent 3,419,720. Dec. 31, 1968. Filed Sept. 7, 1965.

A special holder is disclosed for use in securing a shape-retaining dosimeter element during a readout operation, which holder consists of a metallic support with side portions to releasably engage in a physical restraint opposite sides of the shape-retaining dosimeter element during the readout operation. The dosimeter element is inserted into the holder, and the holder is then inserted into a readout instrument. In one form, the holder includes an apertured screen to overlie the dosimeter element. In all cases, at least 50% of the surface of the dosimeter element facing the readout mechanism is exposed. (U. S. Pat. Gazette)

14051 THERMOLUMINESCENT HEAT STABLE LITHIUM FLUORIDE DOSIMETER. Hartin, W. J. (to United States Atomic Energy Commission). U. S. Patent 3,427,452. Feb. 11, 1969.

A radiation dosimeter having improved linear response at low levels of radiation comprised of a substrate of a heat-stable polyimide-acid plastic having a layer of granular lithium fluoride bonded to the surface of the substrate with a thin binder coating of polyimide-acid plastic is described. (AEC)

14052 WIDE-RANGE GAMMA-RAY DOSE-RATE METER. Srdoc, D. (Inst. Ruder Boskovic, Zagreb). pp 1021-6 of Radiation Protection. Part 2. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

Properties of gas-filled detectors have been discussed in connection with their use in portable dose-rate meters. It has been pointed out that the relatively long dead time of a GM counter causes a serious limitation to high dose-rate measurements. Since GM counters offer some advantages in comparison with ionization chambers (substantially higher current output per unit dose-rate) an attempt has been made to obtain a wide range dose-rate meter by using a newly developed GM counter tube. A substantially shorter dead time of the order of a microsecond has been obtained. The new counter tube does not saturate until 10^9 r/hr in the Geiger region. Several tubes have been tested up to 5×10^5 r/hr in the proportional region without observing saturation phenomena or radiation damage after prolonged exposure. Schematic diagrams of a portable dose-rate meter and a monitoring system for a kilocurie ^{60}Co source using the newly developed tubes have been presented. (auth)

14053 DOSIMETRY OF IRRADIATION BY HIGH-ENERGY PROTONS BY MEASURING ^7Be. Legeay, G. (Commissariat a l'Energy Atomique, Fontenay-aux-Roses, France); Jeanmaire, L.; Daburon, M. L.; de Botton, N.; Bertrand, S.; Tardy-Joubert, Ph.; de Kerviller, H. pp 835-42 of Radiation Protection. Part 2. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968. (In French).

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.2)).

The utilization of particle accelerators at very high energies poses problems of dosimetry in case of accidental irradiation. An original method for the measurement of the absorbed dose during high energy proton irradiation was proposed at the Vienna Conference in 1965, based on an activity-dose relation in animal tissue. The analysis by γ spectrometry immediately after irradiation shows radioelements with very short periods and these elementa are β^+ emitters, yielding annihilation photons at 511 keV. After 36 hrs, a peak appears and persists at the level of 479 keV. It shows the γ emission of ^7Be whose period is 53.6 days. This ^7Be is produced by spallation reactions caused by the very high energy protons on the nuclei of animal tissue. The activity reported on the day of irradiation by using the physical period of ^7Be is connected to the absorbed dose by a proportionality coefficient independent of the energy of the protons used in the interval from 600 MeV to 2.8 GeV and equal to 0.023 ± 0.003 pCi/g. rad, by taking into consideration the most recent value of the branching ratio of the ^7Be γ rays. A series of experiments were made to verify the possibilities of this method whose practical application presents difficulties inherent with the distribution of the absorbed dose in the organism and with the diffusion of ^7Be formed. (tr-auth)

14054 RADIATION PROTECTION–DOSIMETRY SYSTEM FOR IMPROVED MEASUREMENT OF ENERGY DOSES. Maushart, R.; Piesch, E. (Kernforschungszentrum, Karlsruhe, Ger.). pp 803-11 of Radiation Protection. Part 2. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968. (In German).

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.2)).

Dosimeter systems for the dose determination of γ radiation were described. The dosimeters differ from previous dosimeters as their reading is directly proportional to the absorbed dose. The different calibration of personnel dosimeter to the phantom and the site dosimeter in free air irradiation permits the comparison of the measurement values of personnel and site dosimeters. For application in radiation protection, dosimeters were described which are characterized by a low energy and directional dependence of the dose reading. It is shown how these dosimeters can be so arranged that they show the energy dose absorbed in a given critical organ. The special methods of calibration can reduce the effect of the body back scattering and the body orientation within certain limits. The examples from dosimeter systems show that the radiation protection measurement of the absorbed energy dose can be to a large extent realized. (tr-auth)

14055 THERMOLUMINESCENCE CHARACTERISTICS OF LiF CRYSTALS AFTER REACTOR IRRADIATION. Lyushina, A. F. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser., No. 5, 36-9(1968). (In Russian).

Various LiF crystals were subjected to a 5×10^{16} n/cm^2 irradiation in the vertical exposure holes of a reactor. A possibility of determining the irradiation doses in the 10- to 5000-Mrad range by means of LiF crystal luminescence is presented. (auth)

14056 DOSIMETRY STUDIES AND RADIOLYSIS OF AQUEOUS SOLUTIONS OF CHLORAL HYDRATE. Reyes L., J. (Univ. Nacional de Mexico, Mexico City); Reyes L., S. A.; Limon M., M. A. Rev. Mex. Fis., 17: 263-87(1968).

The radicals involved in the radiolysis of 0.2 M aqueous solutions of chloral hydrate are identified by means of the electron paramagnetic resonance and mass spectrometry data of irradiated polycrystalline powder and single crystals of chloral hydrate. Dosimetry studies were also done with aqueous solutions of chloral hydrate at several molar concentrations. The variation of pH of the irradiated solutions with dose may be used as a dosimetric relation in the 10 to 700 rads dose interval with good accuracy. (auth)

14057 AN INFRARED STIMULABLE PHOSPHOR DOSIMETER WITH TIME LAPSE INDICATION. Sidran, Miriam (Grumman Aircraft Engineering Corp., Bethpage, N. Y.). Appl. Opt., 8: 79-83(Jan. 1969).

A novel procedure for radiation dosimetry that indicates both the magnitude of the dose and the time elapsed since exposure is described. It was tested using an ir stimulable ZnS phosphor to record gamma doses in the range 10^{-4} to 10^{4} R. When the phosphor is exposed to two successive ir bands, the dose and time information are separated and retrieved by means of the two stimulated luminescence peaks. Time lapse indicating dosimetry is applicable to particle radiation, as well as electromagnetic radiation. Readout can be performed by other means than ir, and energy detected in other forms than luminescence. The method should prove useful in tracing the causes of large accidental dose exposures of personnel. (auth)

Radiometric Instruments

Refer also to abstract 13950.

14058 (NYO-3735-1) KRYPTONATE HYDROGEN DETECTION SYSTEM. Final Report. Cucchiara, Orlando; Goodman, Philip; Rex, Roy (Panametrics, Inc., Waltham, Mass.). May 1968. Contract AT(30-1)-3735. 35p. Dep. CFSTI.

A prototype model of a multipurpose instrument which demonstrates the applicability of the Kryptonate® technique for detecting hydrogen gas was developed. The construction of the instrument and a laboratory evaluation of its performance are described. Performance was excellent. The instrument was designed to detect hydrogen in air at concentrations of 0–3% by volume, and to detect hydrogen in nitrogen or other inert gas at concentrations of 0–10% by volume. Other detection levels (both higher and lower) could be set if required. Ultimate response times can be made of the order of 0.5 seconds. The instrument is an all solid state device operating from 120V 60 Hz power source. The instrument has been designed to enable modifications to be made with a minimum amount of difficulty. (auth)

14059 NEUTRON MEASUREMENTS OF MOISTURE IN ARABLE LAYER. Emel'yanov, V. A.; Sinitsyn, V. I.; Beskin, L. I.; Evseev, Yu. K. At. Energ. (USSR), 26: 10-14(Jan. 1969). (In Russian).

The available surface neutron (n-n)-moisture meters do not permit moisture measurements across the whole depth of the arable layer as they are capable of operating at a depth of 10 to 12 cm only. A (n-n) + n-scopic method has been suggested for measuring mean and stratified moisture in the arable layer 20 to 30 cm in depth and reducing errors. This method is based on gradual insertion of a fast neutron source to a depth of up to 25 cm and allows measurement of the slow neutron density on the soil surface. For example, with the source placed at a depth of 0, 10, 15 or 20 to 25 cm, determination of moisture is made possible from the values of the slow neutron counting rate for the following depths; 0–8, 0–12; 0–20; 0–30 cm. (auth)

14060 SCANNING-TYPE RADIATION MEASURING INSTRUMENT. Umeda, Syozo (to Kobe Kogyo Corp.). Japanese Patent 1968-23159. Oct. 4, 1968. Filed June 9, 1965.

The method proposed is applicable for a thickness meter with a radiation source and a detector, which run repeatedly in a direction at right angles to the length of a wide belt material. A function-generating device, which gives an output proportional to the output of a detector (relative to the zero-thickness value), is attached to the combination of radiation source and detector. By the output of this function-generating device, the degree of amplification in the amplifier to the detector is controlled, in order to compensate for the error at the measuring position. (NSA of Japan)

14061 USE OF GAMMA RAY AND THERMAL NEUTRON WELL LOGS TO CORRECT MACROSCOPIC ABSORPTION CROSS SECTION MEASUREMENTS. Mills, William R. Jr. (to Mobil Oil Corp.). U. S. Patent 3,420,998. Jan. 7, 1969. Filed Sept. 17, 1965.

The specification discloses a technique and system for producing and utilizing gamma ray and thermal neutron logs to correct macroscopic absorption cross section measurements obtained in pulsed neutron well logging operations. In the embodiment disclosed, there is provided a well logging system including a pulsed neutron source, a thermal neutron detector, and a gamma ray detector for obtaining the thermal neutron and gamma ray logs. The macroscopic absorption cross section measurements are obtained from thermal neutrons detected. Correction is carried out by forming the ratio between the thermal neutron and gamma ray logs and multiplying this ratio by the macroscopic absorption cross section measurements. (U.S. Pat. Gazette)

14062 WORKPIECE SUPPORT AND MASK ASSEMBLIES FOR RADIATION BACKSCATTER MEASURING INSTRUMENTS. Lieber, Sidney U.; Hay, William D. (to Unit Process Assemblies, Inc.). U. S. Patent 3,421,000. Jan. 7, 1969. Filed Oct. 22, 1965.

A workpiece support and mask assembly for a beta particle backscatter thickness measuring instrument which defines an exposure opening or aperture of conveniently variable size and/or shape so that the instrument can be expeditiously used for measurements on workpieces of widely varying size and shape is described. (B.G.D.)

14063 OPREDELENIE PLOTNOSTI I VLAZHNOSTI GRUNTOV PO RASSEYANIYU GAMMA-LUCHEI I NEITRONOV. (Gamma-Ray and Neutron Scattering Method for Determining Soil Density and Moisture). Osipov, V. I. Moscow, Izdatel'stvo Moskovskogo Universiteta, 1968. 160p.

A brief review is given on the theoretical aspects and up to date methods for measuring soil density and moisture using γ rays and neutrons. Descriptions are given of the portable field devices and the precision measuring techniques. Various factors affecting nuclear methods are reviewed and practical examples are given of various types engineering-geological studies and surveys. 148 references are included. (R.V.J.)

14064 ECONOMY OF RADIOACTIVE GAUGES. RADIOACTIVE GAUGES AND ITS ECONOMICAL EFFICIENCY OF CONSTRUCTION. Okajima, Nobuo; Yamamoto, Moriyuki. Genshiryoku Kogyo, 14: No. 11, 32-5(Nov. 1968). (In Japanese).

In the inspection and control of construction works, radioisotopes are variously used, for example, in moisture and density meters, then in the foundations, road building, etc. The state of such utilizations and the problems involved are described in the following: moisture and density meters (insertion and surface types, problems in the meters); and, some examples of their application (measurement of the foundation hardening effect, measurement in the road building, quality control of concrete). (NSA of Japan)

14065 ECONOMY OF RADIOACTIVE GAUGES. RADIOACTIVE GAUGES AND ITS ECONOMICAL EFFICIENCY OF CHEMICAL INDUSTRY. Nagumo, Tadashi; Ooizumi, Chihiro. Genshiryoku Kogyo, 14: No. 11, 36-9(Nov. 1968). (In Japanese).

The utilization of radiation measuring instruments in the industry is outstanding in recent years. The utilization is closely related to the modernization of plants and to the increase in labor cost, where high economy resulting from the employment is achieved. The utilization and merits of radiation measuring instruments in the chemical industry are described in the following: an outline of the RI measuring instruments (thickness, level, etc., meters); utilization in the chemical industry (comparison between Japan and other countries, and the state of utilization as compared with other industries); and advantages of using RI measuring instruments. (NSA of Japan)

14066 ECONOMY OF RADIOACTIVE GAUGES. RADIOACTIVE GAUGES AND ITS ECONOMICAL EFFICIENCY OF PULP AND PAPER INDUSTRY. Tsukada, Shigeru. Genshiryoku Kogyo, 14: No. 11, 28-31(Nov. 1968). (In Japanese).

In Oji Paper Co., Ltd., weight meters, moisture meters and level meters, using radiation, are employed. The β-ray weight meters, of which the utilization in paper machines is rapidly increasing in recent years, are described in the following: problems in measuring the weight (tolerable error in the measurement, variation in the measured weight, variation in the moisture, variation in the direction of width); measurements in the direction of width (characteristics of the paper machine, weight and moisture meters, variation between the directions of width and flow, scanning in the direction of width and the measuring accuracy); measurements in the direction of flow (automatic weight control, measuring accuracy, time constant and dose); economics in employing the weight meter. (NSA of Japan)

14067 ECONOMY OF RADIOACTIVE GAUGES. RADIOACTIVE GAUGES AND ITS ECONOMICAL EFFICIENCY IN IRON AND STEEL INDUSTRY. Iizima, Hiroshi; Inamoto, Kinya. Genshiryoku Kogyo, 14: No. 11, 24-7(Nov. 1968). (In Japanese).

According to a survey by the Atomic Energy Bureau, the utilization of radioisotopes and radiation in the iron and steel industry is the second largest only to the chemical industry, as of March 1967, the number of enterprises using them is about 57. In the same industry, they are mostly used as sealed radiation sources. The state of their such utilization and the resulting merits are described in the following: an outline of the uses; thickness meters; moisture meters; density meters; level meters; the interlock in coke furnaces; relays and alarms in the rolling process. (NSA of Japan)

14068 ECONOMY OF RADIOACTIVE GAUGES. CAPACITY AND RELIABILITY OF RADIOACTIVE GAUGES. Mizukoshi, T. Genshiryoku Kogyo, 14: No. 11, 19-23(Nov. 1968). (In Japanese).

There are two aspects of determining the performance of radiation measuring instruments: demands in their utilization; and, possibility of extending their performance. The first being more important, the reliability is now considered as a part of their performance. The performance and reliability of radiation measuring instruments are described under the following categories: performance and accuracy; reliability; examples concerning the accuracy (systematic and statistic errors, accuracy and reproducibility, errors due to movement); examples concerning the reliability; reliability of the gamma relay. (NSA of Japan)

14069 ECONOMY OF RADIOACTIVE GAUGES. ECONOMICAL ASSESSMENT OF RADIOACTIVE GAUGES. Sato, Otomaru (Tokyo Univ.). Genshiryoku Kogyo, 14: No. 11, 13-18(Nov. 1968). (In Japanese).

The amount of savings by utilizing radiation measuring instruments in the industry is reported to have reached 160 to 200 million dollars by 1962 in the world; the amount should be nearly a few times more than the figure, at the present time, considering the subsequent development. The evaluation of the economics in employing radiation measuring instruments in the industry is described in the following: the factors of economy (saving in the materials, saving due to the reduction in failed manufacture, saving in labor cost, and saving due to the increase of productivity); installation cost for the measuring instruments; indexes of the effect of economy; the economy in balance, some examples of calculation of the economics. (NSA of Japan)

14070 ECONOMY OF RADIOACTIVE GAUGES. RECENT APPLICATIONS OF RADIOGAUGING IN PROCESS CONTROL. Wada, Nobuo (Japan Atomic Energy Research Inst., Tokyo). Genshiryoku Kogyo, 14: No. 11, 8-12(Nov. 1968). (In Japanese).

The utilization of radioisotopes in industry in Japan was initiated in about 1956. And for the past 12 years since that time, efforts were concentrated on the development of such instruments with high stability, high accuracy, and rapid response. The number of radiation measuring instruments in Japanese industries, as of March 1966, is 931, an increase of about 1.6 times that of 1962. Among the kinds of instruments, the number of density meters increased the most, followed by the thickness and level meters. The present state of application of thickness meters, density meters, level meters, moisture meters, analytical instruments, and tracers in process control is discussed. (NSA of Japan)

14071 REMOTE MEASUREMENT OF DISPLACEMENT BY USE OF A γ-RAY SOURCE. Noltingk, B. E.; O'Neil, P. C. (Central Electricity Research Labs., Leatherhead, Eng.). J. Phys., E (London), 2: 198-200(Feb. 1969).

A technique is described by which displacements can be measured remotely. The screening of a γ-ray source is altered by the displacement, so altering the intensity of radiation, which can be measured some distance away, even outside a thick, absorbent wall. The method is appropriate for displacements down to a fraction of a millimetre. (auth) (UK)

14072 DESIGN STUDIES OF A GAMMA-RAY SCATTER ATMOSPHERIC DENSITY GAUGE BY A MULTIVARIABLE SEARCH METHOD. Gardner, R. P.; Whitaker, D. R. (North Carolina State Univ., Raleigh). Nucl. Appl., 6: 217-24(Mar. 1969).

A multivariable search method is used to predict the optimum design parameters of a gamma-ray scatter gage for the measurement of the atmospheric density on Mars. The gage design parameters are incorporated into mathematical models that can be used to calculate the signal and noise responses of the gage. Then the optimum performance criterion, which consists of the noise-to-signal ratio squared, is minimized by searching these models over the allowable range of values of the gage design parameters. The optimum values of gamma-ray energy, source–detector distance, and lower and upper discriminator settings found in this manner were 106.4 keV, 225 cm, 67.2 keV, and 83.5 keV. (auth)

14073 SOME PROBLEMS OF AUTOMATIC CONTROL IN GRINDING CIRCUIT. Fushimi, Hiromu (Waseda Univ., Japan). Fusen, No. 35, 1-4(July 1968). (In Japanese).

Some problems are discussed with regard to the automatic control in the grinding circuit of mining works. Applications of x-ray absorptiometry(1), neutron absorptiometry(2), and analysis by coefficient value of radioisotopic radiation source(3) are pointed out for quality stabilization in receiving, mixing, milling, and grinding raw ores. As for (3), graphic figures are drawn with measured values of content ratios of mixed systems containing ferric sulfide, quartz sand, limestone, clay, and others using ^{241}Am, and ^{137}Cs radiation sources. (NSA of Japan)

14074 INTRUSION DETECTION USING NUCLEAR RADIATIONS. Wing, James (Argonne National Lab., Ill.). Nucl. Appl., 6: 190(Mar. 1969).

The feasibility of using a ^{57}Co (0.8 m Ci) gamma source and a NaI (Tl) scintillation detector to trigger an alarm system in order to detect door intrusion is discussed. (B.G.D.)

Miscellaneous Instruments and Components

Refer also to abstract 13888.

14075 (BNL–13258) USE OF A DIFFERENTIAL VOLTAGE COMPARATOR AS AN ALARM LEVEL CONTROL. Chester, John (Brookhaven National Lab., Upton, N. Y.). [nd]. 9p. (CONF-690103–7). Dep. CFSTI.

From Health Physics Society Midyear Topical Symposium, Los Angeles, Calif.

The purpose of most fixed radiation monitoring instruments is to provide an alarm when the radiation levels being monitored exceed a predetermined value. It is therefore necessary to provide reliable alarm circuitry if the purpose of the primary instrument is to be effective. Although meter relays are the most common alarm level control now in use they have several limitations. Contact type relays prevent the indicating meter from exceeding the alarm set point and they are limited to only one up-scale point and one down-scale point. The non-contact type meter relay is expensive and in both types the alarm level can only be set at the indicating instrument. The disadvantages of the meter relay can be overcome by using a differential comparator in the form of an integrated circuit which is small, reliable and inexpensive. It can be connected to operate with either a positive or negative signal. The alarm level control can be set accurately and is stable over long periods of time. The control can be located on the primary indicating instrument or at any remote location. The circuit requires so little power from the indicating instrument that several alarm points can be used. The circuit is wired in a fail-safe manner in that any failure of the indicating instrument, the differential comparator, or any other component will result in an instrument failure alarm. Alarm circuits using Fairchild μA 710 differential comparators have been in use at Brookhaven's High Flux Beam Reactor air monitoring system for over a year without failure. (auth)

14076 (CEA-CONF–1148) LINEAR LOGARITHMIC PULSE CONVERTER. Harmanci, A.; Guillon, H.; Goursky, V. [nd]. 15p. (In French). (CONF-680906–11). Dep.

From International Symposium on Nuclear Electronics, Versailles, France.

Mainly designed for particle identification, this linear-log converter uses the piecewise linear approximation technique. This approximation is performed by a passive non-linear ladder network, including resistors and biased diodes, which constitutes the feedback path of an operational amplifier. The main advantages of this method compared to the usual systems using a transistor as logarithmic element, are a better temperature stability, a larger dynamic range, a high level output, and a good reproducibility on a large-scale manufacture. The open-loop gain of the amplifier is approximately shaped in accordance with the desired amplitude response to keep a constant feedback factor which consequently avoids undesirable overshoots. A relative precision of -1%, referred to the input amplitude, is obtained for a dynamic range of about 300. The rise time is below 0.25 μs. (auth)

14077 (CEA-CONF–1154) FAST PULSE HEIGHT ANALYZER. Goursky, V. [nd]. 14p. (In French). (CONF-680906–10). Dep.

From International Symposium on Nuclear Electronics, Versailles, France.

The essential parts of a 100 MHz pulse-height analyzer of the Wilkinson type are described. The possibilities of this device are available for a convenient utilization up to 8192 channels. The schemes of the most critical functional circuits, such as the stretcher, the linear gate and the low threshold discriminator, include some new features. (auth)

14078 (CEA-CONF–1177) ADAPTATION OF AN ATOMIC ABSORPTION SPECTROPHOTOMETER IN A GLOVE BOX FOR ANALYSIS OF RADIOACTIVE SOLUTIONS. Ganivet, M.; Benhamou, A. (Commissariat a l'Energy Atomique, Cadarache

(France). Centre d'Etudes Nucleaires). [nd]. 29p. (In French). (CONF-681038-2). Dep.

From 12th Conference on Analytical Chemistry in Nuclear Technology, Gatlinburg, Tenn.

A Jarrell-Ash model 82500 atomic absorption spectrophotometer was adapted for use in a glove box for the analysis of solutions of high alpha radioactivity, in particular those of plutonium. The presence of a flame, the use of gases such as acetylene, hydrogen, and nitrous oxide, and the vaporization of sizable quantities of alpha emitters presented safety problems which have been satisfactorily resolved. The use of stainless steel and glass eliminates risk of corrosion in a nitric acid media. The apparatus has been used routinely for the determination of Cr, Fe, and Ni in solutions of plutonium nitrate or uranium contaminated by plutonium. (J.G.B.)

14079 (INR-931) POLARIZED NEUTRON DIFFRACTOMETER AT "EWA" REACTOR. Blinowski, Konrad; Maniawski, Franciszek; Sikorska, Dorota; Vratislav, Stanislav; Dobrzynski, Ludwik. (Institute of Nuclear Research, Warsaw (Poland)). 1968. 31p. Dep.

The polarized neutron diffractometer installed at the EWA Reactor at Swierk is described. The polarization and flipping efficiency, as estimated from the flipping ratio, are in the range 0.994 - 1.000. (auth)

14080 (INR-943) NEON HODOSCOPE. Bonczak, B.; Jatczak, J.; Firkowski, R. (Institute of Nuclear Research, Warsaw (Poland)). 1968. 27p. Dep.

There was a discussion on the principles of operation of Conversi detectors and on their efficiency. A hodoscope system consisting of four trays of 9 m^2 total surface was built from thirty-six thousand Conversi detectors. There was a discussion on the construction of this hodoscope. (auth)

14081 (NSJ-tr-140) STORAGE COUNTERS USING FET'S. Takeuchi, Satoshi; Nishino, Osamu. Translated from Oyo Butsuri, 36: 982-7(Dec. 1967). 12p. Dep.

The characteristics, a modification, and uses of a transistorized storage counter are described. The circuit uses a MOS-type FET as a memory potential reading element. The memory potential decay rate is better than -0.1%/min. at 30°C, 63% R.H. Because of its simple, compact, and light weight feature, the circuit will have many uses in nuclear instrumentations. By a modification of the pumping circuit of the storage counter, it can also serve as a pulse integrator for radiation dosimetry. A simple 15 channel pulse height analyzer utilizing the storage counters as memory devices has been constructed. (auth)

14082 (NYO-3622-20) ULTRASONIC INSTRUMENTATION FOR DETECTION OF INCIPIENT BOILING IN LIQUID METALS. Kartluke, Herbert (Aeroprojects, Inc., West Chester, Pa.). July 1968. Contract AT(30-1)-3622. 54p. Dep. CFSTI.

Ultrasonic instrumentation for detecting the onset of boiling in liquid metals was designed and assembled. Operation of the instrument is based on the ultrasonic power required to induce cavitation in the liquid and is essentially independent of the temperature and the pressure in the liquid metal. Evaluation in molten potassium and molten sodium, in static and dynamic test loops at the Mine Safety Appliances Research Corporation, established relationships between cavitation threshold power and liquid temperature, so that the approach to superheating in a coolant channel can be determined with reasonable accuracy. The installation of such apparatus, which can incorporate a continuous multipoint indicator, in a critical coolant channel appears practical. The ultrasonic probe can penetrate the walls of a vessel via hermetically sealable force-insensitive mounts, and all sensitive parts of the equipment can be remotely located outside a temperature and radiation field. (auth)

14083 (NYO-3717-1) EXTENDED TESTING OF THE METHANE IONIZATION DETECTOR. Final Report. (Melpar, Inc., Falls Church, Va.). Dec. 1968. Contract AT(30-1)-3717. 21p. Dep. CFSTI.

The methane ionization detector packaged under a previous contract AT(30-1)-3298, was tested in mining facilities provided by the United States Bureau of Mines. This testing resulted in effecting some corrective action. This included: rearrangement of components, improved waterproofing of electronic circuitry, conversion to a single-point ground system to prevent ground loop problems, addition of a heater in the detector compartment to prevent condensation of moisture within the detector, balancing of pneumatic loads, addition of a reference air system to improve the unit's response to small and/or slow changes in methane concentration, addition of electromagnetic interference shielding, rearrangement of wiring runs to eliminate cross-talk and pickup problems, the use of coax cable in the high impedance circuitry, etc. Upon completion of the corrective actions, the unit was returned to the Bureau of Mines facilities for re-testing. This re-testing was satisfactorily completed; the unit was operated continuously for 48 hours without giving any false positive indications of methane concentration or failing catastrophically. (B.G.D.)

14084 (UCRL-18568) ON-LINE DATA REDUCTION FROM CARY 14, 15 AND 60 SPECTROMETERS. Itzkowitz, Martin S.; Tomlinson, Barrett L. (California Univ., Berkeley. Lawrence Radiation Lab.). Nov. 13, 1968. Contract W-7405-eng-48. 3p. (CONF-681207-1). Dep. CFSTI.

From Digital Equipment Computer Users Society Conference, San Francisco, Calif.

A 4K PDP 8/S computer with ASR-33 teletype which was installed as the heart of an on-line data reduction system for the Cary 14, 15, and 60 spectrometers is described. Data flow is from the spectrometer through a set of Datex mechanical encoders, through an interface designed to specifications by Berkeley Scientific Laboratories, through the computer, and onto the teletype both as printout and binary punchout. The software system includes a rapid averaging algorithm to eliminate high-frequency noise, a sliding thirteen point least-squares curve fitting, a fully buffered I/O system, and a versatile monitor which virtually eliminates the possibility of unrecoverable operator error. (auth)

14085 (UCRL-50553) PIEZOELECTRIC TRANSDUCERS FOR ACOUSTIC EMISSION MEASUREMENTS. Dunegan, H. L.; Brown, A. E.; Knauss, P. L. (California Univ., Livermore. Lawrence Radiation Lab.). Dec. 13, 1968. 7p. Dep. CFSTI.

An analytical expression for estimating the frequency response of a transducer, which is based on the size of the piezoelectric element and the piezoelectric constants of the material, is presented. Also, transducer design and fabrication techniques for acoustic emission transducers that can be used in the 100 kHz region are described including a transducer which utilizes a split piezoelectric element to achieve a differential response. (W.H.K.)

14086 (UCRL-71480) SOLID-STATE HIGH-RESOLUTION NMR SPECTROMETER FOR MULTINUCLEI APPLICATIONS. Holder, B. E.; Maddux, A. S. Jr. (California Univ., Livermore. Lawrence Radiation Lab.). Jan. 16, 1969. 7p. (CONF-690201-1). Dep. CFSTI.

From 10th Experimental NMR Conference, Pittsburgh, Pa.

A high-resolution NMR spectrometer employing the Hewlett-Packard 5100A frequency synthesizer as the exciting source constructed for multinuclei applications is described. (B.G.D.)

14087 STATIC TYPE CYCLIC MAGNETIC STORAGE FOR NUCLEAR INVESTIGATIONS. Tsitovich, A. P.; Golovin, A. E. (Inst. of Atomic Energy, Moscow). pp 617-25 of Progresso Elettronico. Roma, Rassegna Internazionale Elettronica, Nucleare e Teleradiocinematografica, 1968.

From Conference on the Integrated Circuit, Rome, Italy. See CONF-680454.

A flexible magnetic disc with a buffer device for data smoothing is described for recording nuclear data. A binary magnetic transducer circuit and an arithmetic device for parallel recording are also presented. (W.H.K.)

14088 HIGH SPEED COMMUTATING SYSTEM FOR LOW LEVEL ANALOG SIGNALS. Wilkinson, B. L.; LeVier, P. W. (to United States Atomic Energy Commission). U. S. Patent 3,427,475. Feb. 11, 1969.

A solid state switching system has been provided which solves the problems of commutating a large number of low level analog signals at a high rate of speed. Analog signals indicative of temperature, pressure, flow rate, radioactivity, humidity, etc. in an operating reactor, for example, are monitored sequentially by means of high speed solid state circuitry passed and transformer amplified in a manner to eliminate background noise from the signals. The switching sequence is controlled by a logic address system which operates the various solid state switches to transmit the analog signals in time sequence to a single output line in a very short period of time. (AEC)

14089 SIMPLE QUADRUPOLE MASS SPECTROMETER. Fairbairn, A. R. (Avco Everett Research Lab., Everett, Mass.). Rev. Sci. Instrum., 40: 380-1(Feb. 1969).

Quadrupole mass spectrometers are now well established as highly versatile instruments useful for the separation of both positive and negative ions. They employ very simple electronics and their performance is most likely to be limited by lack of mechanical excellence. The high voltages involved (of order 5000 V) require good insulators to support the conducting rod assembly in a precise array. Sapphire balls have been used both between the conducting rod and an end plate or around the circumference as in the design of Munro. A very simple design, requiring the least number of critical dimensions, is one in which the rods are fed directly into holes in the supporting end plates. Attaching the end plates to

a flat rigid bed also results in an open structure for easy pumping. It is necessary that the rods or end plates be insulators. The rods were made of quartz and the end plates and bed of stainless steel although Invar would be more suitable. (auth)

14090 LIGHT-PULSER MEASUREMENTS ON THE XP 1210 HIGH-SPEED PHOTOMULTIPLIER TUBE. Barna, Arpad; Cisneros, Eugene L. (Stanford Linear Accelerator Center, Calif.). Rev. Sci. Instrum., 40: 370-1(Feb. 1969).

A gallium phosphide diode light source, pulsed by two 0.8 nsec wide pulses spaced at 4, 3, 2.5, and 2 nsec, was used for measurements on the XP 1210 high-speed photomultiplier tube. (B.G.D.)

14091 LINEAR OSCILLATION VISCOMETER. White, M. S.; Solomons, C. (Univ. of Pennsylvania, Philadelphia). Rev. Sci. Instrum., 40: 339-45(Feb. 1969).

The damping of linear oscillations of a thin plate suspended in a fluid from a helical spring is used as a means of measuring viscosity. Though originally designed for use with molten salts at high temperatures and pressures, the apparatus is not limited to such applications; in fact, it offers useful advantages for measurements at ambient pressure and temperature. Density measurements by the Archimedean buoyancy method may be made with the same apparatus by using an immersed body of relatively large volume in place of the plate, under nonoscillatory conditions. The design of the viscometer is presented in detail and its performance is discussed. An important advantage over torsional oscillation devices is the very simple relationship between viscosity and damping of the oscillations. (auth)

14092 ZERO POINT CALIBRATION TECHNIQUE FOR MOESSBAUER SPECTROSCOPY. Sauer, W. E.; Reynik, R. J. (Drexel Inst. of Tech., Philadelphia). Rev. Sci. Instrum., 40: 360-1(Feb. 1969).

A zero point calibration technique, consisting of sandwiching a calibration foil with the material being studied, for Moessbauer spectroscopy is discussed. The method of choosing the calibration foil material is described. (B.G.D.)

14093 ULTRAHIGH VACUUM REFLECTOMETER FOR USE WITH EXTREME ULTRAVIOLET SYNCHROTRON RADIATION. Feuerbacher, B. (Univ., Munich); Skibowski, M.; Godwin, R. P. Rev. Sci. Instrum., 40: 305-6(Feb. 1969).

An ultrahigh vacuum reflectometer is described. It can be used to study reflectance, transmittance, and photoemission on samples evaporated in situ. The angle of incidence can be varied from 0 to ±90° in steps of 7.5°. The system rotates about the axis of the incident light for study of polarization effects. With the polarized continuum of synchrotron radiation and a normal-incidence monochromator the reflectometer allows measurements with polarized light at wavelengths down to about 300 Å. (auth)

14094 SECONDARY ELECTRON YIELD vs PRIMARY ENERGY FOR COMMERCIAL COATED-GLASS RESISTANCE STRIPS. Streeter, J. K. (Wentworth Inst., Boston); Hunt, W. W. Jr.; McGee, K. E. Rev. Sci. Instrum., 40: 307-10 (Feb. 1969).

The mean secondary electron yield has been determined as a function of primary electron energy from 20 to 70 eV for the dynode-strip surface of a commercial resistance-strip magnetic electron multiplier. Both the primary energy and the secondary yield were determined by measuring the multiplier output current while varying the voltage applied to the field-strip input end at each of three fixed dynode-strip input-end voltages. The measured mean secondary yield increases linearly from about 1.2 at 20 eV to about 1.7 at 70 eV. (auth)

14095 APPARATUS FOR THE STUDY OF PROTON SPUTTERING. Finfgeld, C. R.; Furr, A. Keith (Virginia Polytechnic Inst., Blacksburg). Rev. Sci. Instrum., 40: 326-9(Feb. 1969).

An apparatus for the study of proton sputtering, consisting of a differentially pumped ultrahigh vacuum system, rf ion source, electrostatic lenses, and double focusing magnetic spectrometer has been designed and built. The system was capable of delivering a proton beam of energy from 500 eV to 8 keV, and average current density of 1.0 mA/cm^2, to a target at 5×10^{-8} Torr. (auth)

14096 SUM-DELAY AMPLIFIER AND GATE GENERATOR. Simms, P. C. (Purdue Univ., Lafayette, Ind.). Contract AT-(11-1)-1746. Rev. Sci. Instrum., 40: 285-7(Feb. 1969).

The sum-delay amplifier and the gate generator are in separate single-width NIM modules. The amplifier has five input channels which can be switched in or out. The delay can be switch selected to be 0, 1, or 2 μsec. The gate generator is very flexible. It will accept almost any type of input signal and produce an output pulse which can be adjusted to meet most gating requirements. One frequent use of the instrument is to observe the performance of an electronic system while an experiment is being performed. (auth)

14097 PROGRAMMABLE MAGNETIC FIELD MASS SPECTROMETER WITH ON-LINE DATA PROCESSING. Wasserburg, G. J.; Papanastassiou, D. A.; Nenow, E. V.; Bauman, C. A. (California Inst. of Tech., Pasadena). Rev. Sci. Instrum., 40: 288-95(Feb. 1969).

A single focusing, 30.48 cm radius, 60° sector magnet mass spectrometer was constructed with symmetric conjugate foci calculated from fringe field data and corresponding to a beam deflection of 68°. Experimental and calculated optical characteristics agree well. A rotating coil probe and a rate coil are employed as field sensors for a nulling device and for field scanning. The magnetic field can be set to 27 values corresponding to the center of spectral lines and zero lines on both sides of each peak. The automatic scanning consists of: rapid field change between adjacent field values (~500 G/sec); locking in at the preset field values (~0.3 sec); and remaining in a channel for a preset time during which the ion beam current is integrated and the data digitized. Repeated arbitrary excursions between channels do not cause effective field variations of more than $|\Delta B/B| = 2 \times 10^{-5}$. For 0.2 mm source and 0.64 mm collector slit settings, a typical peak at mass 88 is flat for 2.7 G to 0.01% at a 14 kV accelerating potential. Data consist of channel intensity, scale factors, and internally provided clock time; data signals drive a typewriter and tape punch. A cyclic scan of five isotopes including background requires 35 sec. A segment of data (~10 cycles) is processed by the computer and the results returned to the operator. (auth)

14098 SOME LOGARITHMIC PROPERTIES OF PHOTOMULTIPLIERS. Maydan, D.; Shaanan, M. (Israel Atomic Energy Commission, Tel-Aviv). Rev. Sci. Instrum., 40: 218-23(Feb. 1969).

The logarithmic properties of a photomultiplier are investigated. There is a logarithmic relationship between the voltage and gain of a group of three dynodes of a photomultiplier. An exponential current generator for the calibration of logarithmic amplifiers based on these principles is described. The dynamic range of the generator is about 4 decades with an output current of 250 mA. The exponent is constant within a few percent over the entire range. The calibration of a fast logarithmic amplifier is shown. The generator can also be used to simulate the wave shape of fast scintillators with exponents as fast as a few nanoseconds. (auth)

14099 SIMPLE SCANNING ELECTRON MICROSCOPE. Crewe, A. V.; Isaacson, M.; Johnson, D. (Univ. of Chicago). Rev. Sci. Instrum., 40: 241-6(Feb. 1969).

A simple scanning microscope has been built which uses a field emission electron gun alone, without the aid of auxiliary lenses. The design and operation of the microscope are described and the calculated performance is compared with experiment. Resolution of 100 Å has been obtained and is shown in transmission electron micrographs. The probe current is of the order of 10^{-10} to 10^{-11} A, a value which is high enough to allow micrographs to be taken with scan times of 10 sec. (auth)

14100 NEW CRYSTAL SPECTROMETER FOR NEUTRONS. Stedman, R.; Almqvist, L.; Raunio, G.; Nilsson, G. (Aktiebolaget Atomenergi, Nykoeping, Sweden). Rev. Sci. Instrum., 40: 249-55 (Feb. 1969).

A new feature of the spectrometer is the monochromator unit, which contains two parallel reflecting copper crystals and delivers a beam of monoenergetic neutrons through a fixed collimator which is parallel to the incident beam from the reactor. About half the neutrons reflected by the first crystal are reflected by the second crystal, though the fraction declines at the upper end of our energy scale (about 60 MeV). The beam from the monochromator is free from fast neutrons, and the background extremely low. The material, thickness, and mosaic width appropriate to efficient reflection in a monochromator crystal are discussed. The sample and analyzer form a compact separate unit on a stationary base. All the angles of the spectrometer (including those of the monochromator) are continuously variable over wide ranges, with either manual control or automatic control from a programming tape. Two spectrometers which are mirror images of one another are mounted side by side at the same reactor beam hole. They are mainly intended for measurements on phonons with comparatively high resolution. An example of the accuracy attained is given. (auth)

14101 APPARATUS FOR VACUUM DEPOSITION ON A NEGATIVELY BIASED SUBSTRATE. Baum, Gary A.; Beno, Richard L.; Van Vorous, Theodore (to United States Atomic Energy Commission). U. S. Patent 3,428,546. Feb. 18, 1969.

An apparatus is described for the deposition of films on substrates, wherein a filament furnishes electrons to ionize a gas

and a depositant and a tetrode may accelerate depositant ions at low energy toward the substrate. (AEC)

14102 ANNUNCIATOR CIRCUIT. Jones, Robert H. (to United States Atomic Energy Commission). U. S. Patent 3,430,230. Feb. 25, 1969.

An annunciator circuit for generating an audio alarm in response to an event represented by an electrical pulse is described. An SCR is connected across a storage element so as to discharge the accumulated charge on the storage element through a loud-speaker when the SCR is triggered by a signal received from the emitter of a transistor amplifier. (AEC)

14103 EXPERIMENTAL ARRANGEMENT WITH A.P.M. PRINCIPLES FOR POLARIZATION MEASUREMENTS. Prade, H.; Mathe, Gy. (Institut fuer Kernforschung, Debrecen, Hungary). Acta Phys. Acad. Sci. Hung., 25: 83-90(1968). (In Hungarian).

Two measuring arrangements are described, which are based on the associated-particle-method principle, and were developed for polarization measurements. From the coincidence detection of neutrons and ^{3}He particles from the D(d,n)^{3}He reaction, it is possible to obtain a neutron beam of exactly defined energy and direction, moreover, with the detection of ^{3}He particles, satisfactory monitoring is assured. (tr-auth)

14104 FILMS FOR NEUTRON RADIOGRAPHY: AN INVESTIGATION OF FILM-INTENSIFYING SCREEN IMAGE RECORDERS. Hawkesworth, M. R. (Univ. of Birmingham, Eng.). J. Phys., E (London), 2: 235-42(Mar. 1969).

The characteristic curves of induced density against neutron exposure for the film-intensifying screen image recording systems used in radiography with beams of neutrons are shown. The fastest screen in each of the three categories, crystalline, glass and metal foil, was selected for the studies, together with all films of potential use from UK manufacturers. The characteristics of the neutron beam used and the experimental techniques are described in some detail. Spectral response curves for the screens to facilitate adjustment of the characteristics to suit other neutron beams, and some resolving power data, are also included. (auth) (UK)

14105 AN INTEGRATING AIR SAMPLER FOR DETERMINATION OF ^{222}Rn. Sill, Claude W. (Atomic Energy Commission, Idaho Falls, Idaho). Health Phys., 16: 371-7(Mar. 1969).

The actual radiological hazard from radon emitted from tailings piles remaining from processing uranium ores is extremely difficult to assess. Exhalation of radon from the ground varies markedly with time and is particularly dependent on the condition of the surface and the prevailing meteorological conditions. Using present techniques, the sampling required to permit a realistic estimate of the dose sustained by a significant population in a year's time is economically prohibitive. A sampler was developed to collect air continuously at 10 ml/min for 48 hr to provide an integrated sample which can be analyzed to determine the average radon concentration to which people at that location were exposed during the same period of time. A small aquarium aerator pump filtered air through a precision needle valve with a digital indicating handle into a collapsible 40 l. bag made of laminated $^3/_4$ mil Mylar. The pump can be used either directly from an ac line or from a battery with a small power inverter. Each station is resampled at 3-week intervals for a calendar year, amounting to approximately 10% of the total time available. A 1 yr program involving 57 stations in four different cities has been started. (auth)

14106 ANALYSIS OF THE CHANGE IN ENERGY DISTRIBUTION OF FAST ELECTRONS IN SHIELDING USING MAGNETIC BETA SPECTROMETERS. Kononov, B. A.; Antonov, V. M.; Evstigneev, V. V. (Tomsk Polytechnical Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 10, 109-13(1968). (In Russian).

A method for analysis of the change in energy distribution of fast electrons in shielding using magnetic beta spectrometers is described. The main parameters of the apparatus are given. Experimental results for measurement with shielding of thicknesses up to 500 mg/cm^2 are presented. The range of thicknesses were determined by the kinetic energy of electrons (1 – 6 MeV), and the experimental and theoretical results agreed quite well. Results were compared for shielding materials of different atomic numbers as to the ionization processes. A relation between the thickness of the shielding and its effective atomic number is established by the initial energy of the electrons and by the characteristics of the secondary distribution. The degree of influence of crystalline structure on the deformation of the energy spectrum of electrons for shielding of single-crystal alkali-halide salts is investigated. (tr-auth)

14107 NUCLEAR RESONANCE: SIMPLE METHOD OF DETECTION. Sullivan, E. P. A. (Victoria Univ., Wellington, New Zealand). Nature (London), 218: 944-5(June 8, 1968).

Nuclear quadrupole resonance in solids can be effectively examined with a super-regenerative spectrometer, operated in the self-quenching mode or externally quenched. The technique with the self-quenched spectrometer is described, together with some simplifications. The simplified system is amplitude limited and hence does not suffer from amplitude modulation interference effects. Lower quench frequencies can also be used more effectively. A plot of the NQR signal from a polycrystalline sample of $NaClO_3$ at room temperature is shown. (UK)

14108 ON-LINE REACTIVITY METER BASED ON REACTOR NOISE USING TWO-DETECTOR CROSS CORRELATION. Selfritz, W.; Stegemann, D. (Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Appl., 6: 209-16(Mar. 1969).

A prototype on-line reactivity meter using reactor noise analysis techniques is based on a two-detector cross correlation method, which offers as a special feature the absence of uncorrelated noise contribution to the spectral density function of the reactor system. Reactivity shutdown measurements were performed on three different zero power reactors down to −7 dollars. Special attention is given to the predicted and measured error margins of reactivity. The described on-line meter when used with optimized current type neutron detectors for minimum gamma contamination promises to be an encouraging way of making shutdown reactivity measurements, perhaps also in "dirty" power reactors where the high gamma-ray intensities can considerably destroy the clean neutron signal-to-noise ratio. (auth)

14109 OPTICS AND INSTRUMENTATION IN FORENSIC SCIENCE. Lucas, D. M. (Centre of Forensic Sciences, Toronto). Appl. Opt., 8: 15-20(Jan. 1969).

The great variety of materials examined in a forensic science laboratory requires the use of many techniques and instruments. Most of these involve optical components, and a brief description of some applications of some of these is outlined. The two most commonly used instruments are the microscope and the camera; some unusual applications of the latter are described. Also, some applications of spectrophotometers, x-ray diffraction equipment, neutron activation analysis, and gas chromatography are described. (auth)

14110 FORENSIC OPTICS. Walls, H. J. (Metropolitan Police Forensic Science Lab., London). Appl. Opt., 8: 21-8 (Jan. 1969).

The uses of various optical methods in forensic science are briefly reviewed — in particular, visual examination, microscopy, x-rays and photography, x-ray diffraction, spectrophotometry, emission spectrography, and neutron activation analysis. Attention is directed to some recent developments, particularly in the methods of bloodstain examination. (auth)

14111 MULTICHANNEL ANALYZER. Yoshimura, Naoki; Yoshikane, Akishige; Kono, Takuji (Tokyo Shibaura Electric Co., Ltd.). Toshiba Rev., Int. Ed., No. 39, 23-9(Nov.-Dec. 1968).

The multichannel analyzer, or wave-form/pulse-height analyzer, is a statistic analyzer comprising an A-D converter and a small fixed-program type digital computer, capable of characteristic measurement of random phenomena (for example, radiant-ray measurement) and characteristic analysis of phenomena accompanied by variation or noise; these functions are performed in a short time and with high accuracy. (auth)

14112 DISPLAY OF NEUTRON RADIOGRAPHY RESULTS BY DIRECT VIEWING OF A SCINTILLATING PLATE. Hendry, I. C.; Spowart, A. R.; Robertson, J. A.; Oliphant, A. J. (United Kingdom Atomic Energy Authority, Dounreay, Scotland). J. Phys., E (London), 2: 191-2(Feb. 1969).

Results are given of some experiments to measure the light output from NE 102 and NE 421 scintillators under neutron radiographic conditions. These are then used to interpret an experiment in which an image intensifier was used to provide immediate radiography by direct viewing of a scintillating plate placed in the Materials Testing Reactor neutron radiography unit at Dounreay. (auth) (UK)

14113 FET ELECTROMETER (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1816).

1 drawing.

The circuit for an all solid state (FET) linear electrometer is described. The electrometer is packaged in a six-unit-wide standard NIM chassis and has self-contained +24, ±12 and +550 V power supplies. The current range is from 10^{-5} to 3×10^{-13} A with provisions for extension to 3×10^{-14} A. The electrometer is protected from input overload transients to 1000 V and has short circuit protection for the amplifier and power supplies. Relays and circuits for high-level alarm indication, and additional space are provided for the inclusion of a caution-level alarm indicator.

A calibration signal is provided for alarm functions. (For details see TID-4100 Suppl. 50). (F.S.)

14114 CAMERA FILTER ATTACHMENT (Engineering Materials). (Los Alamos Scientific Lab., N. Mex.). CAPE-1822).

6 drawings.

A film attachment for a Debye-Scherrer camera is described. The attachment helps reduce the film darkness caused by background radiation during phase identification of small radioactive samples. Alpha background can be completely eliminated and β background is eliminated with a small attenuation of x radiation. (For details see TID-4100 Suppl. 50). (F.S.)

Radiation Effects on Instruments and Instrument Components

Refer also to abstract 14913.

14115 (INR-942) RADIATION DAMAGE IN SILICON SURFACE BARRIER DETECTORS. Chwaszczewska, J.; Krogulski, T.; Piasecki, E.; Tys, J. (Institute of Nuclear Research, Warsaw (Poland)). 1968. 12p. Dep.

Silicon surface-barrier detectors were tested for radiation damage caused by fission fragments and neutrons. It was established that for devices made of low resistivity silicon (approx. 50 Ωcm) the doses of 5×10^9 fragments/cm^2 and 10^{11} fission neutrons/cm^2 are tolerable if it is confined only to distinguishing between light and heavy fragments. (auth)

14116 EFFECTS OF IONIZING RADIATION ON MOS DEVICES. Andre, B.; Buxo, J.; Esteve, D.; Martinot, H. (CNRS, Toulouse). Solid-State Electron., 12: 123-31(Feb. 1969).

The properties of the space-charge region induced in the oxide film by ionizing radiation were studied. The experiments described show that a steady state is reached when either a constant gate-voltage or a constant drain voltage and current is maintained during irradiation. A model is suggested which assumes that the effects of irradiation are the creation of electron-hole pairs within the oxide and the injection of electrons from the cathode. (auth)

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Refer also to abstracts 13668, 13669, 13693, 13740, 13780, 13781, 13785, 13974, 14150–14152, 14177, 14214, 14232, 14233, 14238, 14277, and 14290.

14117 (NYO–2356-33) STUDIES OF THE EFFECTS OF ULTRAVIOLET RADIATION ON CELL STRUCTURE AND BEHAVIOR. Annual Progress Report, December 1967–December 1968. Freed, Jerome J. (Institute for Cancer Research, Philadelphia, Pa.). Dec. 10, 1968. Contract AT(30-1)-2356. 146p. Dep. CFSTI.

Tissues from the tailbud of Rana pipiens embryos and from embryos of Bufo americanus were used to establish a number of cell culture lines. Procedures for initiating and maintaining anuran embryo cell lines are described in detail. Cultured cells were exposed to a dose of 5,000 rad x radiation, 7,500 rad ^{60}Co γ radiation, uv radiation, or chemicals, including colchicine, vinblastine, ethyl methane sulfonate, and D_2O and effects on survival, ultrastructure, and induction of chromosome aberrations were studied. (C.H.)

14118 (ORNL-tr–2035) BODY DISTRIBUTION OF URANIUM IN DOGS LONG PERIODS AFTER THE INHALATION OF URANIUM OXIDE. Tikhaya, M. G.; Novikova, A. P.; Parfenov, Yu. D. Translated for Oak Ridge National Lab., Tenn., from Med. Radiol., 10: No. 10, 50-4(1965). 11p. Dep. CFSTI.

Twenty minutes after a single inhalation of U_3O_8 in a concentration of 135.10^{-4} mg/l, approximately 29% of the total amount of inhaled substance was retained in the lungs of dogs. The inhalation of the slightly soluble U_3O_8 resulted in a long-term deposition of the aerosol particles in the organs and tissues, where the uranium was detected even 60 months after inhalation in concentrations exceeding the content of natural uranium. During the initial period after inhalation, the major organ of deposition was the lung, but after prolonged periods (toward the 60th month) most of the uranium was deposited in the skeleton. Over prolonged periods of observation, the maximum uranium concentration was found in the mediastinal and bronchopulmonary lymph nodes, where it exceeded the average concentration in the lungs by a factor of 550 to 870. During the period from the 23rd to the 60th month after inhalation, the most slowly excreted fraction of the uranium was found in the lungs following an initial value of 10.1% of the total retained amount, and was eliminated with a half-life of 280 days. (auth) (TSS)

14119 EFFECTS OF ULTRAVIOLET IRRADIATION (2537 A) ON THE STRUCTURE OF HUMAN THYROGLOBULIN. Vecchio, G.; Dose, K.; Salvatore, G. (Univ., Naples). Eur. J. Biochem., 5: 422-8(Aug. 1968).

The structure of highly purified, uv-irradiated human thyroglobulin was investigated by following the ultracentrifugal pattern and the appearance of free sulfhydryl groups in the irradiated protein. Thyroglobulin (19S) dissociated into two 12S subunits when it was irradiated with doses of a few hundred Einsteins per mole. The quantum yields of dissociation varied between 0.5×10^{-3} and 2×10^{-3}, depending on the experimental conditions. At higher uv doses, the protein was partially aggregated and denatured. The extent of dissociation was largely dependent on the ionic strength and the pH of the medium. Doses up to 1500 Einsteins per mole caused only a partial (30%) splitting of the 19S molecules, at neutral pH in 0.1M KCl, whereas at pH 10 and low salt ($\Gamma/2 = 0.0042$), the same dose produced almost complete dissociation into 12S subunits. Ultraviolet light also caused the rupture of some of the disulfide bonds of native thyroglobulin. On irradiation with several hundred Einsteins per mole protein, as many as 21 -SH groups per molecule could be titrated. The quantum yields for -SH production and destruction of cystine residues were both 0.05. No direct correlation was found between the extent of dissociation of thyroglobulin and the number of -S-S- bonds cleaved, nor between the reassociation of the 12S subunits and the reoxidation of -SH groups. It is concluded that two 12S units present in human thyroglobulin are not linked by interchain disulfide bridges; the disulfides cleaved by uv irradiation, however, may play an important role in maintaining the subunit organization of the protein molecule. (BBB)

14120 EFFECT OF A SOLUBLE FRACTION OF OIL SEED MEALS ON UPTAKE OF ^{65}Zn FROM Ca.Mg.^{65}Zn.PHYTATE COMPLEXES BY THE CHICK. Lease, J. G. (Clemson Univ., S. C.). J. Nutr., 96: 126-38(Sept. 1968).

A study was made of the uptake of ^{65}Zn by the chick from certain fractions of phytate-containing oil seed meals in relation to the varying availability of the meal Zn in vivo, and of conditions in vitro which could account for availability of Zn bound by a casein digest, as compared with Zn bound by phytate. The insoluble Ca · Mg · ^{65}Zn · phytate complex and the corresponding soluble fraction of 61 sesame meal (61 SM); Zn unavailable to the chick, and of Venezuelan sesame meal (VSM); Zn available, were prepared by an in vitro method simulating the chick's initial digestive processes. Inclusion of the soluble fraction of 61 SM with its ^{65}Zn · phytate complex did not significantly increase uptake of ^{65}Zn by blood, liver, or tibiae. Inclusion of the soluble fraction of VSM significantly increased uptake from its phytate complex. It was postulated that VSM contained precursors of substances which form a more stable bond with Zn than does phytate during the digestion process; Zn is available from this complex; 61 SM lacks these precursors. The soluble fraction of soybean meal (SBM) contained about 75% of the extracted Zn; uptake of ^{65}Zn from this fraction was comparable to that from $^{65}ZnCl_2$. Inclusion of the unlabeled SBM fraction with the ^{65}Zn · phytate complex of 61 SM or VSM resulted in a significant increase in uptake of ^{65}Zn. SBM may contain a substance which could render the Zn of an insoluble phytate complex available in vivo. The ^{65}Zn added to a casein digest was bound at intestinal pH; dialysis to water was low but about 50% of the ^{65}Zn dialyzed to blood. Little dialysis of ^{65}Zn to blood or water occurred with phytate-containing sesame digest. During the process of digestion in vivo, Zn may be bound in the presence of many foodstuffs; the avidity with which Zn is taken up by blood components will influence its absorption. (BBB)

14121 EFFECTS OF D_2O ON THE ALLOSTERIC PROPERTIES OF BOVINE LIVER GLUTAMIC DEHYDROGENASE. Henderson, Rogene F.; Henderson, Thomas R. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Arch. Biochem. Biophys., 129: 86-93(Jan. 1969).

Deuterium oxide was found to affect the allosteric properties of glutamic dehydrogenase in the following manner: The polymer form was stabilized against dissociation by NADH in D_2O; the inactive monomer appeared to be stabilized. GTP was more inhibitory and ADP was less stimulatory in D_2O; the presence of D_2O was found to protect the enzyme against the irreversible denaturation caused by dilution at low ionic strengths. While GTP speeded up this denaturation in H_2O, it did not increase the slow denaturation rate in D_2O, thus adding to the evidence that D_2O stabilizes the inactive monomer. (auth)

14122 X-RAY INDUCED BINDING OF N-ETHYLMALEIMIDE TO DNA IN AQUEOUS SOLUTION. Johansen, Ivar; Ward, John F.; Siegel, Knut; Sletten, Arild (Norwegian Defence Research Establishment, Kjeller). Biochem. Biophys. Res. Commun., 33: 949-53(Dec. 30, 1968).

Investigations were initiated to test the possibility that N-ethylmaleimide can react with DNA during x-irradiation. A model system, DNA in aqueous solution, was used. Tritium-labeled DNA in aqueous solution was x-irradiated in nitrogen and in oxygen in the presence of ^{14}C-NEM. A graph is presented to show x-ray induced binding of NEM to DNA; no binding occurs in the presence of oxygen. X-ray induced binding occurs in deoxygenated solutions as a function of the molar concentration of NEM to the molar concentration of DNA. (H.L.W.)

14123 EVIDENCE FOR THE PRESENCE OF CYTOSINE PHOTOHYDRATES IN UV IRRADIATED NUCLEIC ACIDS. Grossman, Lawrence; Rodgers, Elinor (Brandeis Univ., Waltham, Mass.). Contract AT(30-1)-3449. Biochem. Biophys. Res. Commun., 33: 975-83(Dec. 30, 1968).

Methods of preparing 5-^3H-polycytidylic acid and 5-^3H-cytosine-labeled Escherichia coli DNA are described. Solutions were irradiated with monochromatic uv light at 10 ergs/mm^2/sec. Cytosine photohydrates were detected by a combination of the exchange reaction of 5-^3H-labeled cytosine compounds with the medium together with the release of such a label under dehydration of reversal conditions. A table is presented to show quantum yield for cytosine photohydrate formation. The data show that cytosine hydration exists and that its level is sufficiently high to warrant its implication in the biological effects of uv. (H.L.W.)

14124 METABOLISM OF SELENIUM COMPOUNDS IN THE RAT. Lipinski, Stanislaw; Sluzewska, Leonia (Inst. of Hygiene and Epidemiology, Warsaw). Rocz. Panstw. Zakl. Hig., 19: 405-10(1968). (In Polish).

Excretion and distribution of ^{75}Se in male Wistar rats, 24 hr

after per os administration of $Na_2{}^{75}SeO_3$, were investigated. The rats received 3.95 μg, 2.5 mg, and 5.0 mg of Na_2SeO_3 per Kg of body weight, doses that corresponded to 0.0018, 1.15, and 2.30 mg/Kg of Se. The rats were killed by decapitation, and the radioactivity of urine, feces, blood, kidney, liver, and spleen was measured by a scintillation counter. Increased ^{75}Se excretion was observed at the dose levels of 1.15 and 2.30 mg/Kg, as compared with that after trace amounts of this element had been administered. Excretion of Se after 1.15 mg/Kg had been given was found to exceed that after 2.30 mg/Kg doses. A similar relation was noted in an earlier study involving spectrophotometric measurements of the nonradioactive Se. Among the organs examined, most intensive metabolism of ^{75}Se was observed in kidney and liver (kidney > liver > blood > spleen). (BBB)

14125 THE CHANGES IN FLUORESCENCE OF ACRIDINE ORANGE-STAINED HeLa CELLS DURING ULTRAVIOLET ILLUMINATION. Bushong, Stewart C. (Baylor Univ. Coll. of Medicine, Houston, Tex.); Watson, Joseph A.; Atchison, Robert W. Stain Technol., 43: 273-7(Sept. 1968).

Fluorescence of acridine orange stained biological specimens may be used to characterize the effects of ultrasound, visible light, and ionizing radiation. The technique is based upon the differential fluorescence of DNA and RNA in acridine orange stained specimens. When a properly stained specimen is viewed with a fluorescence microscope, DNA-containing structures appear green and RNA-containing structures, red. Following radiation injury, both the intensity and the color shown by the fluorescence may be altered. The intensity of fluorescence decreases during uv illumination, and this fading may interfere with the examination and interpretation of the fluorescence response. Experiments were designed to provide quantitative data on such fading, as seen in HeLa cells during uv illumination. HeLa cells were stained with a 1/12,000 concentration of acridine orange at pH 7.2 for 3 min and the fluorescence emission was measured quantitatively for effects of uv irradiation for durations including intervals between 5 and 210 min. The total photometric fluorescence intensity increased for the first 30 min, then decreased with illumination time. The initial maximum fluorescence intensity occurred at 525 nm and shifted progressively to shorter wavelengths. Fluorescence intensity above 580 nm decreased with increasing duration of illumination time while that below 580 nm showed an initial decrease in intensity followed by a gradual fading. It is concluded that the fading should not interfere with the analysis of fluorescence if analysis is completed within 5 min after the start of uv illumination. For quantitative measurements of a more sensitive nature, the fading of fluorescence and the spectral characteristics of the photometer may have to be accounted for. (BBB)

14126 KINETICS OF ^{137}Cs ISOTOPIC EXCHANGE BETWEEN VARIOUS SEAWEEDS AND SEAWATER. Parekh, J. M.; Talreja, S. T.; Doshi, Y. A. (Central Salt and Marine Chemicals Research Inst., Bhavnagar, India). Curr. Sci. (India), 37: 700-2(Dec. 20, 1968).

Marine algae were collected from the Veraval and Okha coasts of India and placed in filtered sea water. Cesium-137 was added to the containers as CsCl in HCl. Algae were removed at daily intervals, dried, and examined by gamma spectrometry. Results are presented for red algae (Gelidiella acerosa, Gracilaria millardeti), brown algae (Sargassum johnstoni), and green algae (Ulva fasciata). Cesium-137 was concentrated most rapidly by red algae. A graph is presented to show the ratio of activity in algae to that in sea water as a function of time of uptake. The great abundance of potassium in sea water is thought to influence the uptake of ^{137}Cs. An equation is given for evaluating the steady state concentration factor. (H.L.W.)

14127 HEMOPOIETIC PROGENITOR CELLS IN MARROW AND SPLEEN OF MICE WITH HEREDITARY IRON DEFICIENCY ANEMIA. Bennett, M.; Pinkerton, P. H.; Cudkowicz, G.; Bannerman, R. M. (Roswell Park Memorial Inst., Buffalo. State Univ. of New York, Buffalo. Buffalo General Hospital). Blood, 32: 908-21(Dec. 1968).

Sex-linked hypochromic anemia is the result of iron deficiency, apparently caused by malabsorption of iron. Progenitor cells in marrow and spleen of male anemic (genotype, sla/–) and normal (+/–) littermate mice were studied by quantitative transplantation into irradiated, but otherwise normal, recipient mice. The progeny of grafted cells were assessed by isotope uptake technics. Progenitor cells of sla/– mice were capable of extensive production of erythroid cells, which synthesized DNA and hemoglobin, and of leukocytic elements, which synthesized DNA but not hemoglobin. Proliferation of the latter cell types was assayed in recipient mice rendered polycythemic with red cell infusions to suppress erythropoiesis. The mature red cells produced by transplanted sla/– marrow and spleen were normal with respect to volume, size, and hemoglobin content. The grossly enlarged spleens of sla/– mice contained 20 times the normal number of erythropoietic progenitor units (EPU); parental iron therapy cured the anemia and caused the spleen to revert to normal. The ratio of EPU to leukopoietic progenitor units (LPU) was abnormally high in marrow and spleen of sla/– mice; in addition, the EPU : LPU ratio was higher in spleen than in marrow of normal and anemic mice. The high EPU : LPU ratio of sla/– bone marrow persisted after transplantation to a lesser, but significant, extent for at least 52 days. We conclude that: the sla mutant gene does not affect hemopoietic cells directly, but that iron deficiency alters the ratio of EPU to LPU by committing more primitive pluripotent stem cells to erythropoiesis, and EPU and LPU are separate progenitor cells with restricted potential for differentiation. Persistence of the altered EPU : LPU ratio in sla/– marrow chimeras may be explained by extensive and independent self-replication of EPU and/or LPU, especially after grafting relatively small numbers (1.6 million) of marrow cells into irradiated mice. (auth)

14128 HEMATOPOIESIS IN LONG-TERM SURVIVAL FOLLOWING SUPRALETHAL IRRADIATION AND BONE MARROW TRANSPLANTATION IN DOGS. Chertkov, J. L.; Novikova, M. N.; Nemenova, N. M.; Malanina, V. N. (Central Inst. of Hematology and Blood Transfusion, Moscow). Blood, 32: 895-907(Dec. 1968).

An active phase of regeneration of hematopoiesis in supralethally irradiated dogs attains subnormal levels within 1 to 1.5 months following exposure in cases of transplantation of autologous bone marrow; with allogenic bone marrow transplants subnormal regeneration is attained 2 to 2.5 months following exposure. In the latter case the duration of chimerism is no longer than 35 days. Active regeneration is accompanied by restoration of the indices of thrombo-, erythro-, and granulopoiesis. Lymphopoiesis is not restored within long-term observation. Subsequently animals given either autologous or allogenic bone marrow transplants show development of a secondary hypoplasia of the hematopoietic and lymphoid tissues persisting throughout the entire duration of observation (up to three years). Sites of ectopic hematopoiesis are observed in the lymph nodes, spleen, right heart, lungs, and liver. The bone structure is acutely damaged, as evidenced by resorption and incomplete regeneration of the osseous trabeculae. It has been presumed that the secondary affection of hematopoiesis is associated with radiation lesions of the stroma in the hematopoietic organs. (auth)

14129 THERAPEUTIC REDUCTION OF THYROIDAL IRRADIATION FROM ^{131}I BY THE USE OF POTASSIUM IODIDE AND THYROID STIMULATING HORMONE. Blum, Manfred; Eisenbud, Merril (New York Univ. Medical Center, N. Y.). pp 1309-15 of Radiation Protection. Part 2. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.2)).

Experiments have been conducted in euthyroid adults for the formulation of procedures designed to reduce thyroidal radioiodine burdens in the event of iodine absorption due to accidental exposure. The rate of reduction of thyroidal radioiodine concentration was measured by daily external scintillation counting twenty centimeters anterior to the neck in eight healthy adults who had received 10 μCi of ^{131}I for clinical purposes, the difference between neck and thigh activity reflecting thyroidal burdens. After the retention slope had become constant, the subjects were given KI 200 mg orally and/or thyroid stimulating hormone (TSH) 10 U intramuscularly. In a typical subject the ^{131}I effective half-life ($T_{\frac{1}{2}}^{E}$) was 6.0 days during the control period, 5.5 days during 48 hr when two doses of TSH were given at 24 hr intervals, 2.6 days during 72 hr when KI and TSH were given daily, and 6.1 days during 72 hr when KI was given alone fourteen days after the use of TSH had been discontinued and the retention slope had returned to control levels. In the other subjects the range for the $T_{\frac{1}{2}}^{E}$ during the control, TSH and TSH/KI periods was 6.0 to 7.3, 5.3 to 5.8, and 1.7 to 2.6 days respectively. The TSH/KI effect is of short duration as shown in one subject who received one dose of the combination. During each of the first three twenty-four hour periods the ^{131}I $T_{\frac{1}{2}}^{E}$ was 3.4, 5.6, and 5.7 days with a pre-treatment control of 6.3 days. The indications are that TSH co-administered with KI may be effective in substantially reducing the dose commitment of the human thyroid from the absorbed dose of ^{131}I. Considerations about the safety of the regimen will be discussed. (auth)

14130 RHYTHMICAL CHANGES OF THE ELECTROPHORETIC MOBILITY OF ERYTHROCYTES AFTER IRRADIATION WITH INCREASING X-RAY DOSES. Tribukait, B. (Karolinska Inst., Stockholm). Nature (London), 219: 382-3(July 27, 1968).

Studies indicated that the electrokinetic potential of suspended

mouse erythrocytes changes rhythmically after increasing x-ray doses in a manner similar to colloidal quartz, carbon or gold particles. Experimental details are described, and results shown graphically. The x-ray data were 165 kV, 5mA, 1Al, 12.4 R/min at 22.5°C. The electrophoretic mobility was determined by direct observation at 37°C in a cell-electrophoresis apparatus (the mobility is directly proportional to the electrokinetic potential). The mean electrophoretic mobility for washed cells was found to be $-1.492 \pm 0.090\ \mu s^{-1}\ V^{-1}$ cm. Within the investigated dose range of up to 75R the maximum values occurred at about 9, 29, 50, and 69R, and the minimum values at about 19, 42, and 56R. Changes in electrokinetic potential appeared to be stable for at least 6 hrs after irradiation. In a second series of experiments the purpose of which was a closer approximation to in vivo conditions the mean electrophoretic mobility was found to be -1.421 ± 0.042, and rhythmic changes were observed. Experiments were also conducted to investigate in vivo irradiated erythrocytes; under these conditions no unambiguous rhythmical variation could be proved to exist, but a number of values deviated significantly from initial values. Composition of the medium surrounding the cells, and their interaction with ionization processes, probably play an essential part in irradiation effects on the electrokinetic potential of the cells. (UK)

14131 SHORT HALF-TIMES OF ^{137}Cs IN PREGNANT WOMEN. Zundel, W. S.; Tyler, F. H.; Mays, C. W.; Lloyd, R. D.; Wagner, W. W.; Pendleton, R. C. (Univ. of Utah, Salt Lake City). Nature (London), 221: 89-90(Jan. 4, 1969).

The equivalent biological half-times of ^{137}Cs were evaluated in 24 pregnant women, whilst the environmental levels of fallout ^{137}Cs were still sufficiently high that artificial administration was not required. The average half-time of 49 days was only 58% of that in 15 non-pregnant controls. Complications during pregnancy were taken account of in interpreting the results. The results verify the findings of others in that pregnancy accelerates the excretion of Cs; possible mechanisms are mentioned, with preliminary studies to test them. Changes in renal function appear to be the most likely explanation. If the exact mechanism were understood it might be possible to accelerate removal artificially in individuals or populations with high ^{137}Cs levels. (UK)

14132 METABOLIC STUDIES OF ^{85}Sr IN EXPERIMENT. Kindzel'skii, L. P.; Mechev, D. S. (Kiev Scientific-Research Inst. of Experimental and Clinical Oncology). Med. Radiol., 13: No. 12, 49-53(Dec. 1968). (In Russian).

The distribution of Soviet-made ^{85}Sr in the organism, its excretion, behavior in bones, as well as its influence on myelopoiesis was studied in rats and mice. It was divulged that ^{85}Sr accumulates predominantly in the bone tissue, irrespective of the type and site of its localization, maintaining large concentrations for a period of several days. One-half of the introduced activity is eliminated by the organism within 4 days; whereas by the bone it took 15 days. The administration of 15 and 60 μCi/kg body weight caused neither toxic manifestations nor hemopoietic inhibition. It was concluded that ^{85}Sr is a prospective isotope for the diagnosis of bone pathology. (auth)(C.O.)

14133 DIRECT AND INDIRECT RADIATION EFFECTS ON POTASSIUM TRANSPORT BY EHRLICH-ASCITES TUMOR CELLS. Hasl, G.; Pauly, H. pp 198-203 of Molekulare Struktur und Strahlenwirkung. Glubrecht, H. (ed.). Stuttgart, Georg Thieme Verlag, 1968. (In German).

From Annual Meeting of the Molecular Structure and Radiation Effects, Hanover, Ger. See CONF-660671.

The direct and indirect radiation effects on potassium transport caused by diffusing energy carriers were studied. The results on Ehrlich-Ascites tumor cells show that in the irradiation of cell suspensions short-lived radiation products, in addition to the H_2O_2, are formed. The energy carriers formed in the suspension medium diffuse into the cell membrane. They affect the absorption rate and the final concentration of potassium in the cells. If the indirect radiation effect is eliminated during the irradiation through thick layers of cells, doses 8 to 10 times higher are required in order to have the same final concentration of potassium. The exchange rate of potassium remains the same. (tr-auth)

14134 NUCLEIC ACID CONTENT AND NUCLEIC ACID SYNTHESIS IN SACCHAROMYCES CELLS AFTER X IRRADIATION. Takamori, Y.; Lochmann, E.-R.; Laskowski, W. pp 194-7 of Molekulare Struktur und Strahlenwirkung. Glubrecht, H. (ed.). Stuttgart, Georg Thieme Verlag, 1968. (In German).

From Annual Meeting of the Molecular Structure and Radiation Effects, Hanover, Ger. See CONF-660671.

The effect of x radiation at various doses on the nucleic acid content and nucleic acid synthesis in Saccharomyces cells was studied by determining the RNA and DNA content per dry weight of the cell mass of haploid and diploid cells after exposure. The results showed that the RNA content was only slightly decreased, while the DNA content was sharply reduced. Studies on the radio-induced inhibition of RNA synthesis showed that the RNA synthesis is very radioresistant. In studies of stock with various degrees of ploidy, an increase of the radiation resistance from haploid up to hexaploid stock was established. If the inhibition of the RNA synthesis is observed at various times after irradiation and after incubation of the irradiated cells, it is established that the cells directly after irradiation at high doses are inhibited only slightly in their RNA synthesis. Only after a long incubation time can a significant radiation damage be established. (J.S.R.)

14135 STUDIES ON MUTANTS OF K12(λ) SHOWING AN EARLY DEFECT IN LAMBDA DEVELOPMENT. Eisen, Harvey Arnold Melvin. Toronto, Univ. of Toronto, 1967.

Thesis.

The genetic locations and functions of mutations in λ bacteriophage, in which phage DNA synthesis was blocked, were determined using defective prophage. These mutants were found to map in four district cistrons; cistrons N, O, and P, and the x region, a new locus. The physiological properties of the various mutants were also studied after induction of the defective prophage. With the exception of P22, DNA synthesis was not observed with any of the mutants, after induction. In order to determine whether the host killing accompanying induction of defective prophage was due to diffusible phage products or was a result of prophage excision itself, the survival of lysogens carrying the defective prophage on an extra-chromosomal attachment site (the F-gal episome), were examined. It was found that induction of the DNA defective prophage from this location did not result in host death, but with the exception of mutants in the x region, did result in the loss of the episome. It was thus concluded that the lethal event in induction of the DNA defective mutants was due to prophage excision. A model was suggested in which it was proposed that excision of the prophage resulted in the interruption of the host chromosome. It was also proposed that the interruption of the host chromosome could be repaired to various extents in the various mutants; mutants in the x region could efficiently repair the interrupted chromosome, mutants in cistrons O and P had a limited ability to repair the host chromosome, while mutants in the N cistron could not repair the damage. To test the above model the effects of zygotic induction of DNA defective mutants on the linkage between the bacterial markers on either side of the prophage were examined. It was found that this linkage was completely destroyed after zygotic induction of mutants in the N cistron. Zygotic induction of mutants in cistron O resulted in a 5-fold depression in the linkage, while induction of mutants in cistron P and in the x region resulted in complete restoration of the linkage. The effects of temperature induction of the DNA sus mutants on host survival and DNA synthesis were also examined and the results obtained are discussed with respect to the model for prophage excision. (TSS) (Disser. Abstr.)

14136 THYMUS-MARROW IMMUNOCOMPETENCE. IV. THE GROWTH AND IMMUNOCOMPETENCE OF TRANSFERRED MARROW, THYMUS, AND SPLEEN CELLS IN PARENT AND F_1 HYBRID MICE. Claman, Henry N.; Chaperon, Edward A.; Hayes, Lawrence L. (Univ. of Colorado Medical Center, Denver). Transplantation, 7: 87-98(Feb. 1969).

The growth and function of bone marrow, thymus, and spleen cell suspensions were studied after injection into irradiated recipients. Parental and F_1 hybrid mice (C57L, A/He, and C57L × A/He) were used as both donors and recipients. Marrow cell function was shown by enlargement of the recipient spleen. Thymus cell function was indicated by the enhanced antibody production to sheep RBC by combinations of thymus and marrow cells. Spleen cell function was shown by production of antibodies to sheep RBC. Both marrow and spleen cells showed hybrid resistance, i.e., they functioned better when donor and recipient were syngeneic (either parent → parent, or $F_1 \rightarrow F_1$) than when they were allogeneic (parent → F_1, or F_1 → parent). Similarly, C57BL thymus cells functioned well in C57L but not in LAF_1 hybrid recipient strains. Thymus cells, on the contrary, functioned as well as LAF_1 as in A recipients. Growth of F_1 marrow was inhibited by parental thymus cells only in syngeneic parental recipients and not in F_1 recipients. This may represent the immunological reequipment of irradiated parental hosts by parental thymus cells. Hybrid resistance was not seen if parental spleen cells were enclosed with antigen in Millipore diffusion chambers and placed in F_1 recipients. This suggests that hybrid resistance depends upon contact between parental and F_1 cells. (auth)

Ecology

Refer also to abstracts 13668, 13669, and 14176.

14137 ABSORPTION OF ^{226}Ra IN CULTIVATED PLANTS. Kirchmann, R. (CEN, Mol, Belg.); Boulenger, R.; Lafontaine, A. pp 1045-51 of Radiation Protection. Part 2. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968. (In French).

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.2)).

The absorption of ^{226}Ra by several cultivated plants (barley, beet, cabbage, carrot, potato, Ray grass, and violet clover) was examined by studies in test fields and greenhouses. Gamma spectrometry was used for the measurement of the ^{226}Ra content in various samples. During greenhouse studies, the effect of Ca deposition in the hydroxide and chloride forms on the ^{226}Ra absorption was studied. Comparisons of the absorption of ^{226}Ra by Ray grass were made for five different soils and two contamination levels; the results showed that there is an inverse correlation between the ^{226}Ra of the plant and the quantity of sorptive material of the soil. The results of field studies over three years, in a sandy soil whose upper layer had previously been contaminated to different levels with ^{226}Ra, were reported. These results show that there are differences between the absorption of ^{226}Ra among the vegetable species studied; the distribution of ^{226}Ra in the plants is not uniform. In general the O.R. values [(^{226}Ra/Ca) plant/(^{226}Ra/Ca) soil = O.R.] show the presence of a very strong discrimination against ^{226}Ra in the transfer between the soil and the plant. (trauth)

14138 THE TRANSFER OF ^{210}Po FROM CATTLE FEED TO MILK. Watters, Robert L.; McInroy, James F. (Colorado State Univ., Fort Collins). Health Phys., 16: 221-5(Feb. 1969).

^{210}Po has been proposed for use in radionuclide electrical generators in space missions. Accidental release of the quantities of this material required for such an application could lead to the contamination of large areas. One of the hazards of such an accident could be the transfer of ^{210}Po from contaminated dairy pasture to man through the milk supply. A study is described in an attempt to estimate the magnitude of this problem from a ^{210}Po acute ingestion experiment with one Holstein cow. With the use of assumptions regarding the feeding of cattle and the intake of milk by man an estimate of the surface deposition to produce a maximum permissible body burden is made. (auth)(UK)

14139 RADIO-ECOLOGICAL STUDIES OF ENVIRONMENTAL RADIO-ACTIVITY TO MAN. Takizawa, Yukio (Niigata Univ., Japan). Niigata Igakkai Zasshi, 82: 565-8(Sept. 1968). (In Japanese).

The conditions of radioactive fallout and regional contamination of food and drink in Japan are described. The stratospheric substances have strong affinity to human body, and ^{90}Sr, accumulation of which on the surface of the earth surpassed 10 MCi, and ^{14}C, which remains for a long time as the constituent of DNA, are particularly important. The conditions of selective accumulation of nuclear substances by human internal organs, the effect of radioactive giant particles on the human body, and troubles in lung and respiratory system due to inhalation of Pu in utilization of nuclear energy were described. The total ban of nuclear experiments and the necessity of countermeasures to keep the harm to man at a minimum were emphasized. (NSA of Japan)(TSS)

14140 COMPOSITIONAL CHANGES OF ECOSYSTEM SEGMENTS DURING CHRONIC GAMMA IRRADIATION. Garrett, Arthur Randolph Jr. Atlanta, Emory Univ., 1968. 142p. Thesis.

A series of observations were made on segments of granite outcrop ecosystems during chronic γ irradiation. Samples were taken on ten dates during a 14-month period. Dose rates covered the interval from 161 to 0.1 R/hr for total doses ranging between 1356 and 0.8 kR. Samples of vegetation, litter arthropods and soil nematodes were quantitatively studied. The number of nematodes generally declined with increasing irradiation. The values of the index of similarity and 10 diversity indexes for the vegetation and litter arthropods are presented as annual progressions or in terms of their regression on radiation exposure and time. Similarity considerations seem more informative regarding vegetation changes. Diversity indexes seem more appropriate to describing changes in litter arthropod samples. The indexes are useful as concise descriptive statements of change in taxonomic composition of ecosystems. (Diss. Abstr.)

Genetics and Cytogenetics

Refer also to abstract 14117.

14141 (ORO-2832-75) EFFECTS OF RADIATION AND OTHER AGENTS ON THE MOLECULAR STRUCTURE AND ORGANIZATION OF THE CHROMOSOME. Cole, Arthur; Corry, Peter M. (Anderson (M. D.) Hospital and Tumor Inst., Houston, Tex.). Nov. 5, 1968. Contract AT(40-1)-2832. 2p. (CONF-690302-1). Dep. CFSTI.

From 23rd Annual Symposium on Fundamental Cancer Research, Houston, Tex.

The structure and properties of isolated mammalian mitotic chromosomes were studied using phase and interference contrast light microscopy, stereo electron microscopy, and ultracentrifugation sedimentation techniques. Alterations induced by various treatments were observed using agents such as x radiation, salts, hydrolytic enzymes, pH, mercaptans, and others. Effects of radiation on molecular structure and morphology are described. (H.L.W.)

14142 (ORO-2976-19) GENETIC AND CYTOGENETIC ANALYSIS OF THE EFFECTS OF RECURRENT IRRADIATION AND CHEMICAL MUTAGENS ON GENERAL AND SPECIFIC COMBINING ABILITY IN PEARL MILLET, PENNISETUM TYPHOIDES. Progress Report, May 1, 1968-April 30, 1969. Burton, Glenn W.; Powell, Jerrel B. (Georgia Univ., Tifton. Georgia Coastal Plain Experiment Station). Jan. 30, 1969. Contract AT(40-1)-2976. 46p. Dep. CFSTI.

The effects of single and combined mutagenic treatments using thermal neutrons and ethyl methane sulfonate were evaluated in pearl millet (Pennisetum typhoides) by testing the combining ability in F_1 hybrids of diallel mated plant progeny from material recurrently treated for three cycles. Excellent stands and reliable forage yield data were obtained from six experiments devoted to this study. Although far from conclusive, the data suggested that the mutagenic agents did increase the percent of non-additive genetic variance in the material studied. Cytological analyses were made of the frequencies and types of chromosome aberrations resulting from thermal neutron irradiation and chemical mutagen treatment of seeds. The third cycle of mutagen treatments was given and examination of plants for variables indicated a well-treated population that carried a heavy load of mutations. The isolation of numerous types of chlorophyll-deficient seedling mutations, as well as mutations for dwarfism, was considered to be potentially beneficial to the breeding improvement of this crop. (C.H.)

14143 IN VITRO PRODUCTION OF CHROMOSOMAL LESIONS WITH AN ARGON LASER MICROBEAM. Berns, M. W.; Olson, R. S.; Rounds, D. E. (Pasadena Foundation for Medical Research, Calif.). Nature (London), 221: 74-5(Jan. 4, 1969).

It seemed probable that laser microbeam irradiation could produce lesions on predetermined sites of selected chromosomes with a compatible in vitro culture system. Studies are described on salamander lung tissue explants, chosen for their hardiness, the presence of numerous well-spread dividing cells, and the large size of the chromosomes. The argon ion laser used emitted pulsed coherent light principally at 5145 and 4880 Å, and since chromosomes do not strongly absorb the wavelengths of the argon laser, acridine orange was used as a photosensitizing agent. The results of focusing the laser on arms of individual condensed chromosomes in an anaphase figure are illustrated. The types of lesions produced were similar to the chromosome paling observed with an uv microbeam. It is stated that, using a laser, a coherent, monochromatic, high energy beam can be focused with normal microscope optics to a very precise focal point, and such a beam can be used to create chromosomal lesions of $<1\ \mu$ in living cells. The use of a photosensitizing agent, however, creates problems of secondary effects and survival, but with the advent of more powerful argon lasers it may be possible to lower the dye concentration, or perhaps omit it, or employ lasers with different wavelengths. (UK)

14144 THE PERSISTENT EFFECT OF ^{60}Co GAMMA-RAYS ON THE CHROMOSOME ABERRATIONS IN THE ROOT-TIP CELLS ON ONIONS. Wang, T. C.; Tang, M. T.; Tao, S. C. Chih Wu Hsueh Pao, 14: 193-7(June 1966). (In Chinese).

Onion (Allium cepa) root tips were γ irradiated at 200, 300, or 400 R from a ^{60}Co source, and the bulbs were returned to water for continued incubation after exposure. Cytological samples were taken on the third day after irradiation, continuing the sampling of the regenerated root-tips at intervals of 3 or 4 days. The irradiated root cells in all groups up to the fifth sample exhibited chromosome bridges, fragments at anaphase and micronuclei at telophase; abnormalities of the nucleoli were seen in the interphase nuclei of the meristem. Analysis of the chromosome abberations of the irradiated root cells in all five samples indicated that the frequency of anaphase and telophase bridges increased with the dose. The radiation-induced chromosome bridges persisted for long periods, even after repeated cell divisions in the root; the ratio between the frequency of anaphase bridges in the first post-

irradiation sample and those in subsequent samples was found to decrease with time. The prolonged effects of radiation on the cell and its progeny are analyzed. (TTT)

14145 OPEN SPIKELET: A RADIATION INDUCED MUTANT CHARACTER IN RICE. Gill, K. S.; Saini, S. S.; George, Mary K.; Kandola, H. S. (Punjab Agricultural Univ., Ludhiana, India). Curr. Sci. (India), 38: 82-4(Feb. 20, 1969).

Following γ irradiation, rice seeds germinated and grew to maturity. Seeds from these plants were collected and planted; two out of eight of the mature plants developing from these seeds exhibited open spikelets. The progeny of these plants exhibited both open and closed spikelets; a table is presented to show proportions of each. It is suggested that the new mutant will be useful in crossing experiments for developing hybrid vigor. (H.L.W.)

14146 THE CHARACTERIZATION OF REVERTANTS OF TWO LOCI IN E. COLI WWU: A STUDY OF RADIATION ACTION ON THE GENE. Phillips, Stephen Lee. University Park, Pa., Pennsylvania State Univ., 1968. 67p.

Thesis.

The mutagenic properties of tritium decay, ultraviolet light and ^{60}Co γ-rays were studied using E. coli WWU. These agents were used to revert two loci, the arginine locus and the thymidylate synthetase gene which both contain nonsense triplets. Revertants were separated into eight classes which consisted of seven classes of cells which contained nonsense suppressors and one class of structural gene revertants. Revertants produced by tritium decay and ^{60}Co radiation were examined. There appeared to be no large mutagenic molecular rearrangement at the site of thymidine-methyl-^{3}H decay. Tritium decay in thymidine-methyl-^{3}H, uracil-6 ^{3}H and histidine-^{3}H appeared to cause mutations by β particle irradiation. Both tritium decay in these precursors and ^{60}Co γ rays did not cause a selective base change but were non-specific, causing both transitions and transversions. Thymidine revertants of WWU were isolated using uv light. Because of the nature of the suppressors found it was inferred that the thymidylate synthetase gene contained an ochre triplet. This was common to all derivatives of E. coli 15 70-462. Pleiotropism was demonstrated by the coordinate suppression of the amber triplet in the arginine locus and the ochre triplet in the thymidylate synthetase gene when either of two classes of revertants which contain ochre suppressors were produced. The expression of a uracil-5H^{3} decay produced mutational lesion causing C → T transition base changes was characterized with the following results: The number of arginine independent revertants per ml is dependent on the concentration of arginine provided for expression. A maximum yield was obtained at 3.5 μg/ml of arginine. When cells which had accumulated uracil-5 ^{3}H decay were spread on medium containing no arginine a time dependent loss of revertants occurred. This loss was not found to be a unique property of the cells containing nonsense suppressors. Seventy six percent of the mutational lesions leading to structural gene revertants were also lost if the isolation was carried out in the absence of arginine. (auth)

14147 MUTAGENIC EFFECT OF ULTRAVIOLET LIGHT ON ACTINOMYCETE SPORES AFTER PRELIMINARY ULTRASONIC TREATMENT. Garina, K. P. (All -Union Scientific-Research Inst. of Antibiotics, Moscow). Antibiotiki, 12: 183-7(1967). (In Russian).

Spores from various Actinomycete strains were subjected to ultrasonic treatment before uv radiation was applied. Untreated spores served as controls. Preliminary ultrasonic treatment increased the lethal and mutagenic effects of ultraviolet radiation. Mutants differed sharply in antibiotic productivity; those possessing increased antibiotic activity were obtained more often from the treated spores. (ATD)

14148 ON THE CHANGES OF SEEDS AND SEEDLINGS BY IRRADIATION, AND CULTIVATION OF USEFUL MUTANTS. 5. Fujiwara, Tatsuyuki; Nishida, Noriyuki (Hyogo Prefectural Agricultural Experiment Station, Japan). Hyogo-Kenritsu Nogyo Shikenjo Kenkyu Hokoku, No. 15, 67-70(Mar. 1968). (In Japanese).

Observations were made on the summer characteristics of ever green and giant green, which are new species of the lettuce. Both ever green and giant green are late in growth, compared with other species in the country. The harvesting of edible leaves is up to the 66th day of seedling age for ever green, and to about the 50th day for Okayama salad; but thereafter, the color and flavor of blades deteriorated. For profitable harvest however, the limit is set to 10 to 15 days before that. With the new species, growth in warm regions and extended growth range are possible. (TSS) (NSA of Japan)

14149 CHROMOSOME ABERRATIONS DUE TO MEDICAL IRRADIATION. Bauchinger, M. Muenchen. Med. Wochenschr., 109: 1008-14(May 5, 1967). (In German).

The current status of chromosome diagnosis in humans after exposure to radiation is discussed. The number of cases examined is relatively small if compared with the frequency of medical irradiation. For this reason it is not possible to arrive at exact quantitative dose-effect relations from the material available so far. We also do not have any evidence for a causal relation between chromosomal aberrations induced by ionizing radiation and possible malignant or degenerative late sequelae. The difficulties of dealing with these questions is also discussed. (auth) (C.O.)

Health Physics and Safety

Refer also to abstracts 13647, 13832, 13833, 13868, 13872, 13896, 13974, 13979, 13984–13986, 14047, 14053, 14105, 14126, 14139, 14221, 14255, 14278, and 15690.

14150 (AEC-tr-7000) RADIATION-HYGIENIC CONDITIONS IN THE FAR NORTH (1959-1965). Ramzaev, P. V.; Troitskaya, M. N.; Ibatullin, M. S.; Moiseev, A. A.; Nizhnikov, A. I.; Kolesnikov, V. V.; Teplykh, L. A.; Ermolaeva-Makovskaya, A. P. Translated from Tr. Radiats. Gig., Leningrad. Nauch.-Issled. Inst. Radiats. Gig., No. 3, 251-60(1967). 9p. Dep. CFSTI.

The transport of ^{137}Cs through lichen-reindeer-man food chains in northern U. S. S. R. during 1962 through 1965 was studied. Samples of air, soil, vegetation, water, snow, berries, potatoes and other vegetables, fish, bones and muscles of reindeer and swine, daily food rations of humans, and human hair, feces, urine, and autopsy samples were analyzed for ^{137}Cs, ^{144}Ce, ^{90}Y, and ^{90}Sr. It was concluded from the data that only ^{137}Cs merits special attention from the health standpoint. Cesium-137 levels in man residing in Arctic regions were greater than in individuals in other locations. A direct relationship was found between the ^{137}Cs levels in human inhabitants, the consumption of reindeer meat by humans, and the consumption of lichens by reindeer. (C.H.)

14151 (ANL-Trans-686) SOME ASPECTS OF TISSUE DOSIMETRY OF ^{226}Ra. Malykhin, V. M.; Shamov, V. P. (Gosudarstvennyi Komitet po Ispol'zvaniyu Atomnoi Energii SSSR, Moscow). Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from report NP-17201. 22p. Dep. CFSTI.

Problems encountered in measurements of the radiation dose from ^{226}Ra in man at various time intervals following exposure are discussed. It is pointed out that accumulation of ^{226}Ra by bone occurs over a period of several years and the biologically important radiation dose does not reach a maximum until five or more years following exposure. Dosimetry problems are complicated by the presence of ^{228}Th in even so-called pure ^{226}Ra, by the radioactive decay of ^{226}Ra and ^{228}Rh, by the content of natural ^{226}Ra in humans, and by metabolic factors affecting the deposition and excretion of ^{226}Ra in humans. Direct and indirect methods for estimation of the radiation dose, based on direct whole-body measurements of γ-activity from decay products of ^{226}Ra in man, or estimations based on measurements of the γ-activity of exhaled ^{222}Rn in breath or on measurements of α-activity in excretory products are discussed. Mathematical calculations used in estimations of radiation dose following single, chronic, or time-limited uptake of ^{226}Ra are included. Data are also included on the radiation dose in man at various times following the uptake of known amounts of ^{226}Ra. (44 references.) (C.H.)

14152 (BNWL-SA-2205) RESEARCH SUPPORTED BY THE UNITED STATES ATOMIC ENERGY COMMISSION ON THE DETECTION AND ASSESSMENT OF URANIUM AND PLUTONIUM BODY BURDENS. Bair, W. J. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Nov. 8, 1968. Contract AT(45-1)-1830. 39p. (CONF-681114-1). Dep. CFSTI.

From Conference on Detection and Assessment of Uranium and Plutonium in the Whole Body and Critical Organs, Vienna, Austria.

For more than 20 yrs the United States has conducted extensive research on problems associated with the accidental contamination of humans with uranium and plutonium as well as with other radioactive elements of the nuclear industry. Programs were developed to determine the fate of these elements in biological systems and their reactions with living cells. The information obtained in these basic and applied programs using experimental animals is being used to assess the hazard to humans contaminated with uranium and plutonium radioisotopes and to establish permissible limits for human exposures. Other programs were established to design and develop sophisticated instrumentation for detecting and measuring small quantities of these radioelements under the conditions required for animal experimentation and for cases of human contamination. All of this work using a

variety of technologies is specifically directed toward radiation protection problems and is supplemented by much basic research in both biological and physical sciences to meet the problems occurring as a result of the expanding use of plutonium and uranium. Most of the current programs related to the detection and assessment of plutonium and uranium body burdens are identified, the objectives of the programs are given, and in some cases recent interesting results are summarized. Abstracts of most of the programs described appear in Research and Development in Progress: Biology and Medicine, published by the United States Atomic Energy Commission. (23 references) (C.H.)

14153 (DUN-SA-77) BIOLOGICAL EFFECTS OF IONIZING RADIATION. Corbit, C. D. (Douglas United Nuclear, Inc., Richland, Wash.). Sept. 16, 1968. Contract AT(45-1)-1857. 21p. (CONF-680930-1). Dep. CFSTI.

From Electromagnetic Spectrum Conference, Richland, Wash.

The relation of dose to direct and indirect effects of γ and x radiation on man is discussed. The characteristics of ionizing radiations, reactions caused by radiation in cells, and factors influencing the radiosensitivity of various tissues are reviewed. Data on the effects of radiation on blood, skin, eyes, gonads, gastrointestinal tract, lungs, nervous system, life span, and tumorigenesis are summarized. Available data on injuries to man following exposure to various doses of radiation are reviewed. It is pointed out that radiation exposure limits established for the protection of the general population should not be applicable to personnel in nuclear industry, since this group does not include persons below 18 yrs or over 70 yrs of age and persons working with radioactive materials are healthier than the general population. It is also pointed out that present standards for the exposure of radiation workers are based on genetic considerations and limit whole-body dose to an average of 5 rems/year, with a maximum dose of 3 rems/quarter of a year, while standards for nonoccupational exposure for the population at large include 0.5 rems/year of whole-body dose. (C.H.)

14154 (EUR-4186) SELECTION OF ABRASIVES AND ADDITIVES FOR DECONTAMINATION BY WET ABRASIVE BLASTING. Mosselmans, G.; Nienhaus, J. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Aug. 14, 1968. 36p. (In German). Dep.

Wet abrasive blasting has been investigated as to its decontamination potentials. Different abrasive materials have been tested looking for a substance universally applicable. The choice has to be made so that decontamination is as complete as possible while neither the material's surface is damaged nor its adsorption qualities are enhanced. The possibilities of surface passivation are examined using various additives to the liquids used for wet blasting. (auth)

14155 (EUR-4187) CLEANING AND DECONTAMINATION OF CLOTHES. Mosselmans, G.; Nienhaus, J. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Aug. 14, 1968. 20p. (In German). Dep.

The development of a process for complete decontamination of cotton-cellulose material is described. The method has been successful in practice for a long time. With complete decontamination the material is not damaged, and problems of waste-water treatment are not caused by the method. Models for fixation of compounds on the textiles are given, which take in account the special cases of radioactive contamination and decontamination. (auth)

14156 (TID-24690) CIVIL DEFENSE: LITTLE HARBOR REPORT. A Report to the Atomic Energy Commission by a Committee of the National Academy of Sciences. (National Academy of Sciences, Washington, D. C.). 1969. 53p. DTIE Free.

A larger number of people should be made aware of the problems that would arise in a nuclear war. In particular, the basic training of recruits to our armed forces should include instruction on the emergency operations necessary in case of a nuclear attack. The people so trained would substitute for, or at least complement, the Civilian Reserve Corps recommended by the original Harbor Report. This recommendation is further discussed in the chapter on Education and Training. The significance of the relations between civil, or passive, defense and active defense, such as antiballistic missiles, is becoming increasingly apparent. It was not possible to study these relations in detail, much less to determine the combination of the two systems that would be most effective. However, the undertaking of such a study by a competent group of reasonable size is strongly recommended. This recommendation is particularly appropriate in view of the recent decision to install a thin antiballistic defense. All participants seemed to agree that the acquisition of a strong civil defense would require a large, well-coordinated, and many-faceted effort. It would also involve great expenditures. In a large-scale war, however, it would save an untold number of lives, would improve the morale of the people, and would reduce the severity of the aftereffects of the war. As an evidence of national resolve, a strong civil defense program would render the tactic of nuclear blackmail less promising. Lesser efforts toward civil defense would have similar effects but of lesser magnitude. (auth)

14157 (TT-67-51409/4) HYGIENE AND SANITATION. Translation of Gig. Sanit., 32: No. 10, 3-123; No. 11, 3-125; No. 12, 3-123(Oct.-Dec. 1967). 504p. (IPST-Cat.-1790; IPST-Cat.-1791; IPST-Cat.-1792). CFSTI.

Separate abstracts were prepared for seven papers in this journal. Abstracts of other papers within the scope of NSA appeared in previous issues. (H.L.W.)

For abstracts of individual papers see: 13624, 13967, 13991, 13992, and 14158-14160.

14158 (TT-67-51409/4, pp 215-21) THE DEVELOPMENT OF SOVIET RADIATION HYGIENE. Krotkov, F. G.; Bykhovskii, A. V. Translated from Gig. Sanit., 32: No. 11, 57-62(Nov. 1967).

A review is presented of the history of Soviet radiation hygiene during the past 50 years. Problems concerning assessment of environmental radioactivity, methods by which radioisotopes penetrate the body, and their effects on health are reviewed. Research on the carcinogenic effects of ionizing radiation on the respiratory tract is discussed. Establishment of maximum permissible levels of ionizing radiation and recommendations of the International Commission on Radiation Protection are discussed. Radiation safety procedures in medical and biological research are reviewed. The development of measures to prevent environmental contamination and to reduce the migration of radioactive isotopes along food chains and their subsequent buildup in the human body is reviewed. (H.L.W.)

14159 (TT-67-51409/4, pp 343-7) HYGIENIC FEATURES OF THE PRODUCTION OF RARE-METAL FLUORIDES. Shalganova, I. V. Translated from Gig. Sanit., 32: No. 12, 28-31 (Dec. 1967).

Experiments were conducted on possible toxic effects of rare metal fluorides. It was concluded that during the industrial production of complex fluorides of tantalum, niobium, and zirconium these compounds may be absorbed by the workers by inhalation as well as via the gastrointestinal tract. In addition to the effect of the complex metal fluorides, assessment of the working conditions includes possible effects of several other factors, such as hydrofluoric acid vapor, α radiation, unfavorable microclimatic conditions, and noise. In contrast to other compounds of rare metals, the fluorides are highly toxic industrial poisons, owing their poisonous properties to the presence of fluorine in the complex. In view of the high toxicity and strong local irritant effect of complex fluorides of rare metals, measures must be taken to prevent the penetration of dust into the air of the working premises, as well as to minimize the direct contact of the workers with the substances. (auth)

14160 (TT-67-51409/4, pp 406-11) MECHANISM OF THE ACUTE TOXIC EFFECT OF RARE METAL CHLORIDES. Spiridonova, V. S.; Suvorov, S. V. Translated from Gig. Sanit., 32: No. 12, 79-82(Dec. 1967).

Toxic effects of tungsten and molybdenum chlorides on rats were studied. A marked irritant effect on the tissues was observed. Necrotic foci were found in the gastric and intestinal mucosa and submucosa as well as in the liver and kidneys. It was concluded that the industrial use of molybdenum and tungsten chlorides in the absence of suitable protective measures involves a danger of acute intoxication, the intensity of which depends upon the amount of the causative agent. In the mechanism of acute toxic effects of the tungsten and molybdenum chlorides, the leading part is played by the chlorine anion. Prophylactic and other medical services for workers must take account of the specific properties of molybdenum and tungsten chlorides as industrial poisons. (H.L.W.)

14161 (UCRL-71327) HEALTH PHYSICS ASPECTS OF TRITIUM CONTROL AT THE LAWRENCE RADIATION LABORATORY, LIVERMORE. Silver, William J.; Chew, Melton H. (California Univ., Livermore. Lawrence Radiation Lab.). Jan. 15, 1969. 23p. (CONF-690103-11). Dep. CFSTI.

From Health Physics Society Midyear Topical Symposium, Los Angeles, Calif.

Operational control including handling techniques and environmental monitoring are discussed. Emergency planning is outlined and spill experience is described. (W.H.K.)

14162 (UCRL-71357) EXPOSURE AND CONTAMINATION CONTROL IN A HIGH-LEVEL ^{147}Pm LABORATORY. Greenhouse, Nathaniel A.; Silver, William J. (California Univ., Liver-

more. Lawrence Radiation Lab.). Jan. 13, 1969. 17p. (CONF-690103-9). Dep. CFSTI.

From Health Physics Society Midyear Topical Symposium, Los Angeles, Calif.

A research program at the Lawrence Radiation Laboratory, Livermore, involved handling of kilocurie quantities of promethium-147 in the development of radioisotope power sources. A high-level plutonium laboratory was reorganized for this work. The low energy of the ^{147}Pm beta necessitated development of special techniques for continuous air monitoring and contamination control. An LRL-designed air monitor and a shoe counter using large-area G.M. detectors are described. Assembly of the power sources involved delicate work which could not be done remotely. Hand exposures from bremsstrahlung and gamma-emitting impurities became the limiting health physics problem. Experiences in exposure and contamination control are discussed. (auth)

14163 (UCRL-Trans-1351(Rev.)) CONTRIBUTION TO THE DOSIMETRY OF pi MESONS. Goebel, K. Translated for Univ. of California Lawrence Radiation Lab., Berkeley, from Z. Naturforsch., 21a: 1808-19(1966). 21p. Dep. CFSTI.

Ionizing radiation with great linear energy transfer capacity and low oxygen enhancement ratio is of great importance for therapeutic uses. Radiation produced by absorption of stopping π^- mesons shows these properties. The physical processes during capture are greatly dependent on the absorbing nucleus. Measurements of the energy absorbed during capture of pi mesons are described. The contribution to the dose produced by the nuclear process is estimated by comparing the doses absorbed during capture of positive and negative pi mesons. The relevance of the Bragg-Gray principle for measuring this nuclear dose and the significance of the tissue equivalence are discussed. By the comparison of depth dose and entrance dose for various types of radiation, it is shown that pi^- mesons of 50 to 80 MeV kinetic energy supply the most favorable conditions for irradiation at 10 cm to 20 cm depth in tissue. (auth)

14164 RADIATION PROTECTION. PART 2. Proceedings of the First International Congress held in Rome, Italy, September 5–10, 1966. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968. 839p. (In Several Languages). (CONF-660920-(Vol.2)).

Separate abstracts were prepared for 62 papers in this conference. Eleven others have previously appeared in NSA. (C.O.)

For abstracts of individual papers see: 13802, 13832, 13833, 13858, 13859, 13877, 13878, 13926, 13927, 14007, 14008, 14052–14054, 14129, 14137, 14165–14207, 14230, 14279, and 15690.

14165 DEPTH DOSE DISTRIBUTION IN A BEAGLE PHANTOM WITHIN A MIXED FIELD OF NEUTRONS AND GAMMA RAYS. Simpson, R. E. (Walter Reed Army Medical Center, Washington, D. C.); Sayeg, J. A.; Lucas, A. C. pp 817-34 of Radiation Protection. Part 2. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.2)).

As a result of the recommendations adopted by the International Commission on Radiological Units and Measurements (ICRU) for Class B irradiations (cases where the irradiation is not uniform because of absorption), a series of investigations for the evaluation of depth dose has been initiated in order to more accurately describe the absorbed dose at all points of interest for different size phantoms. Studies with two phantoms the approximate size of a beagle are reported. These include a homogeneous tissue-equivalent liquid phantom and an Alderson beagle phantom constructed of tissue-equivalent plastic containing a skeleton. The incident radiation field was a mixed field of neutrons plus γ rays within a fast neutron exposure volume of the Walter Reed Research Reactor. The detectors being used in this study are miniature tissue equivalent condenser ionization chambers to measure the total dose (neutron plus γ), Li^7F (TLD-700) for measuring the gamma dose within the mixed field and the threshold detectors of ^{239}Pu, ^{237}Np, and ^{238}U (shielded with ^{10}B) and ^{32}S to obtain the neutron dose. Dose variations with respect to depth are currently being obtained and evaluated for both phantoms. The linear energy transfer (LET) distribution of dose with respect to depth is also being evaluated using the threshold detector technique of Hurst. Results from these evaluations are being compared with those obtained by use of a modified Rossi tissue-equivalent LET proportional counter. The results of the neutron and γ depth dose variations and distribution of neutron LET will be discussed with respect to the techniques employed and input parameters used. (auth)

14166 AN EXPERIMENT TO MEASURE THE TISSUE-EQUIVALENT ABSORBED DOSE (LET) AND DEPTH-DOSE DISTRIBUTIONS PRODUCED BY RADIATIONS IN SPACE. Chapman, M. C. (Northrop Space Labs., Hawthorne, Calif.); Holly, F. E. pp 895-911 of Radiation Protection. Part 2. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.2)).

Measurement of the absorbed dose distribution and depth-dose distribution in tissue-equivalent material is described. Cellular-sized spheres of plastic scintillator were used to detect the dose deposition, and a pulse-height analysis was performed on the signals. The sensor consists of a number of 100 micron spheres of plastic scintillator bonded to a lucite light-pipe. The lucite is cemented to a photomultiplier tube, and the output signal is processed by digital pulse height analyzers. This technique has many advantages over present ion chamber systems, including: measurements of absorbed dose with detector approaching the cellular level, negligible dose gradient through the detector and minimum perturbation of the tissue-equivalent sample, and excellent resolution and gain stability. It appears feasible to measure the absorbed dose distribution spectrum from 0.4 keV/micron to >300 keV/micron with a single sensor. By utilizing multiple sensors with varying amounts of tissue-equivalent pre-filtering, a depth-dose distribution can be obtained. By integrating the absorbed dose spectrum, a measure of the total absorbed dose is obtained. In addition, the experiment provides data on cell hit frequency. The removal of particle type-dependent response and geometrical considerations are discussed. One specific application of this technique involving an astronaut-manipulated space experiment is described. (auth)

14167 RESULTS OF A SPACE DOSIMETRY EXPERIMENT TO ASSESS RADIATION PROTECTION CALCULATIONS FOR MANNED SPACE FLIGHT. Chapman, M. C. (Northrop Space Labs., Hawthorne, Calif.); Fortney, R. E.; Holly, F. E.; Stovall, R. pp 871-93 of Radiation Protection. Part 2. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

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On October 5, 1965, a dosimetry satellite was placed in a retrograde earth orbit with an inclination of 144°. Apogee and perigee were 3460 km and 411 km respectively. This orbit was such that virtually all of the inner Van Allen zone was covered. The instrumentation package consisted of seven separate electron and proton spectrometers (0.56 to 5 MeV for electrons — 10 to 120 MeV for protons), a proton depth-dosimeter measuring absorbed energy at three depths in an aluminum shield, an x ray or bremsstrahlung spectrometer measuring secondary dose behind an aluminum shield, and two tissue-equivalent ionization chambers. Thus proton and electron tissue dose and bremsstrahlung production were measured simultaneously with both uni- and omni-directional radiation environment data. The material distribution of the satellite was experimentally determined and a magnetometer was used to relate spacecraft geometry to particle distributions in space. Therefore, a controlled experiment was performed to investigate the importance of simplifying assumptions in the calculation of proton and electron doses as well as a measurement of the spatial dose and particle distributions. Utilizing this data, representative doses are calculated and compared with the results of the on-board dosimetry. (auth)

14168 DOSIMETRY OF ^{55}Fe. Wrenn, McDonald E. (New York University Medical Center). pp 843-50 of Radiation Protection. Part 2. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

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Recent detection in human blood of radioactive ^{55}Fe produced in nuclear weapon tests has led to a re-evaluation of the dosimetry for this radionuclide which decays exclusively by electron capture. The revised dosimetric estimates for blood are approximately twice those previously calculated. Approximately $^3/_4$ of the decay energy capable of producing ionization is emitted in the form of Auger electrons which have a range of 0.3μ in water. In blood the dose from these Auger electrons is delivered primarily to the erythrocytes which contain relatively large concentrations of stable iron uniformly distributed as hemoglobin. The dose to the erythrocytes is approximately twice that previously calculated for whole blood. As a consequence of the concentration of ^{55}Fe within the erythrocytes, the short range of the characteristic Auger electrons emitted, and the frequency of Auger electron emission relative to x ray emission, the dose to the eryth-

rocytes is 10 times the dose to the rest of the blood, so that this form of exposure is primarily intracellular. A specific activity of 1 pCi of ^{55}Fe per mg of stable iron results in a dose rate of 2 μrad/week to the erythrocytes. This same specific activity in iron-rich aggregates of ferritin molecules may deliver local dose rates up to 800 μrad/week. Although estimates of the amounts of iron in the erythrocyte precursor cells are not sufficiently quantitative to permit accurate dosimetric calculations, the presence of significant concentrations of iron in cells from all stages of erythropoiesis has been reported for rat bone marrow indicating that irradiation of the more sensitive erythrocyte precursors may be significant. (auth)

14169 PROBLEMS OF DOSIMETRY DURING THE CRITICAL ACCIDENT AT THE VENUS REACTOR AT MOL, DECEMBER 30, 1965. Parmentier, N. C.; Boulenger, R.; Portal, G. pp 1231-48 of Radiation Protection. Part 2. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968. (In French).

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The external dosimetry measurements that were made in the hours following the accident to a technician at Mol on December 30, 1965, are described and the results reported. The high doses, 550 R of γ radiation to the film dosimeter carried high on the chest by the technician, were confirmed by Dr. Jammet at Paris. At the request of Dr. Jammet, and with the aid of the dosimeter equipment from his department at the CEA, diverse irradiations of RANDO and REMAB mannequins, provided with external and internal dosimeters, were made in order to guide the treatment of the patient and to permit the comparison of the biological effects. The γ and neutron dosimeter methods and the results obtained are indicated. The irradiation had two characteristics: (1) inhomogeneity, considering the proximity of the source, which imposes the knowledge of the doses at different regions of the body; and (2) instantaneity, which makes possible a relatively precise reconstitution with phantoms. (tr-auth)

14170 EXPERIENCE WITH THE USE OF A CONTINUOUS ALPHA AIR MONITOR, USING LARGE AREA PROPORTIONAL COUNTERS AND AN IMPROVED PSEUDO COINCIDENCE CIRCUITRY. Vaane, J. P.; de Ras, E. M. M. (European Transuranium Inst., Karlsruhe, Ger.). pp 997-1001 of Radiation Protection. Part 2. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

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The construction of a continuous alpha particulate air monitor is described and experience during one year of sampling air from active glove boxes is discussed. The detection of alpha contamination in the presence of natural radioactivity uses the principle of counting pseudo-coincidences between the beta-disintegrations from RaC (or ThC) and the alpha disintegrations from RaC′ (or ThC′). Compared with earlier instruments, a second pseudo-coincidence circuit has been introduced, in which the alpha-pulses arrive 350 μsec later than in the first one. Thus the chance coincidences can be subtracted from the total coincidences, making the instrument very insensitive to changes in the equilibrium between the various radioactive natural daughter products, as well as to a background of beta radiation. A sensitivity of 6×10^{-12} Ci hr m^{-3} (3 mpc hr) has been obtained under normal conditions of ventilation. (auth)

14171 EXPERIENCES IN RADIATION PROTECTION BASED ON EIGHT YEARS OF FUNCTIONING OF THE PLUTONIUM PRODUCTION CENTER. Rodier, J.; Chassany, J. P.; Peyresblanques, H.; Estournel, R.; Court, R. (Service de Protection contre les Radiations, Marcoule, France). pp 975-83 of Radiation Protection. Part 2. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968. (In French).

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The task of a Radiation Protection Service is to protect the personnel and to assure the safety of the production without impeding it. In the Plutonium Production Center, the activities of the Protection Service began with the start-up of the G-1 reactor. The progressive development of the Center has proceeded with the placement of control equipment with a precise role. Some personnel assignments in radioactive environments were worked out. A program of personnel education by means of conferences and posters was started. The results obtained (distribution of the external irradiation dose, case of body contamination, etc.) are discussed. They show that the operation of a nuclear center can be efficient without affecting the safety of the workers. (tr-auth)

14172 DETECTION AND MEASUREMENT OF PLUTONIUM AIRBORNE CONTAMINATION IN MAJOR PLUTONIUM FACILITIES. Brunskill, R. T.; Hermiston, S. T. (United Kingdom Atomic Energy Authority, Windscale, Eng.). pp 961-73 of Radiation Protection. Part 2. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

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A review is presented of air sampling experience in three kinds of plutonium facilities, viz. a laboratory containing lines of glove boxes, a manufacturing facility employing a sealed face to separate operating and maintenance areas, and a workshop used for the cleaning of safety equipment contaminated with plutonium. The level of airborne contamination as measured on fixed, installed air samplers in these areas is shown to be critically dependent on the type of work being carried out, the position of the sampler and the nature of the ventilation system. Personal air samplers invariably indicate higher levels of airborne contamination than these samplers. Over periods of months in the areas under examination, it is generally safe to assume that the integrated exposure measured using personal air samplers will not be more than ten times the exposure measured with the installed samplers. Under incident conditions, however, the installed sampler might underestimate inhalation exposures by several orders of magnitude. The distribution of air sampling data shows a deviation from log normal where incidents occur producing abnormally high airborne contamination. It is concluded from these observations that there is a requirement in certain plutonium areas to use personal air samplers for the measurement of inhalation exposures. In addition, a personal air sampler with an audible alarm has been developed for the early detection of airborne contamination in operating areas. Particle size distributions on air samples have been studied, and their significance is discussed in relation to the assessment of the plutonium inhalation hazard. (auth)

14173 RADIATION PROTECTION REQUIREMENTS FOR FABRICATING RECYCLED PLUTONIUM REACTOR FUEL. Steele, T. A.; Shuck, A. B.; Doherty, P. K. (Argonne National Lab., Ill.). pp 949-60 of Radiation Protection. Part 2. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

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A computer program was developed that calculated the dose rates from plutonium as a function of source weight, geometry, isotopic composition, age, and shielding composition and thickness. Dose rates from plutonium sources were measured and compared with the calculated values. Personnel radiation exposures were monitored during the fabrication of fuel elements containing varying isotopic compositions of plutonium. The information derived from the calculations, radiation measurements, and radiation exposures were applied to glove-box procedures for the fabrication of reactivity coefficient fuel elements. Radiation protection criteria for the fabrication of recycled plutonium are discussed. (auth)

14174 LASER RADIATION PROTECTION. Ham, William T. Jr.; Geeraets, W. J.; Williams, R. C.; Guerry III, D.; Mueller, Harold A. (Medical Coll. of Virginia, Richmond). pp 933-43 of Radiation Protection. Part 2. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

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Although most health physicists and others in the field of radiation protection have confined their efforts primarily to the hazards from the so-called ionizing radiations (x rays, γ rays, neutrons, high energy particles, etc.), an increasing number of workers in this field are being called upon to protect personnel from laser radiation. The phenomenal development of laser technology during the past three years has introduced new hazards for industry, for governmental agencies, particularly the military and space agencies, and for universities and medical schools. The necessity for such criteria is examined. Since the eye is the most vulnerable organ of man to laser radiation, the effects of wavelength, pulse duration, intensity of irradiation (power density), energy density, and other factors on the eye will be given. Current data from several laboratories are reviewed briefly. Finally, protective practices and equipment in current use in the United States are discussed. (auth)

14175 CONTAMINATION OF AIR AND THE RESULTING CONTAMINATION OF GRASS. Courvoisier, P. (Sektion fuer Sicherheitsfragen von Atomanlagen, Wuerenlingen, Switzerland); Nagel, E. pp 1039-44 of Radiation Protection. Part 2. Snyder,

W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

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Since the summer of 1963 a lawn was mowed every second week during the growing season. The β-activity of the consecutive grass samples collected was considered to have been produced by fallout throughout the two week period of regrowth of the grass. It was compared with the activity of the air due to fission products during the same period. In this way an overall deposition velocity was obtained, covering both dry deposition and deposition by rain. This deposition velocity shows considerable scatter and increases during the period of observation. The increase is larger than can be explained by the influence of soil contamination. In addition, the activity found on the grass samples was compared with the activity found on other fallout collectors. Here, too, the ratios increased with time, whereas the ratios between physical samplers stayed constant. (auth)

14176 CONCEPTION AND REALIZATION OF CONTROL OF RADIOACTIVE POLLUTION OF THE FOOD CHAIN. Coulon, R. (CEA, Fontenay-aux-Roses, France). pp 1035-8 of Radiation Protection. Part 2. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968. (In French).

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The utilization of nuclear energy is playing a more and more important part in all regions and it is necessary to have the maximum guarantees with respect to the short-range and long-term consequences of its effects on the health of the population: it is essentially a question of controlling the fixed levels and of extending the knowledge of the mechanisms of transfer and introduction into man in order to put precautions into effect. Thus, in addition to the particular surveillance of certain critical zones, a general surveillance of the medium and the principal alimentary vectors was organized by the Department of Health Protection with the aid of the Minister of Agriculture. The efforts were concentrated on milk, cereals, fruits, and legumes, but it was extended to other products such as meat and fish. The control is based on a rational sampling of foods at the production stage; this sampling follows a localization which allows the superposition of the results from the measurements made at the level of the atmosphere, fallout, and different animal or vegetable production. These results can be interpreted as a function of the local climatic, pedological, agronomic, and zootechnical characteristics. This vertical-type control is completed by the establishment of observation stations where the better knowledge of the conditions cited and the individuality of the samplings authorize more refined interpretations with a more scientific character. (tr-auth)

14177 THE UPTAKE, RETENTION, AND EXCRETION OF INHALED EUROPIUM OXIDE IN TWO HEALTHY ADULT MALES. Ziemer, P. L.; George, R. E.; Kessler, W. V. (Purdue Univ., Lafayette, Ind.). pp 1199-1203 of Radiation Protection. Part 2. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

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Body burdens and activity excreted were repeatedly measured following an accidental europium oxide inhalation by two adult males at Purdue University. Isotopic composition of the europium involved was determined to be 93.4% ^{156}Eu, 3.25% ^{155}Eu, 2.9% ^{154}Eu, and 0.35% ^{152}Eu. Initial body burdens were found to be 55 μCi and 38 μCi of the mixed europium isotopes. Retention following the early rapid elimination processes was described by a power function: $R(t) = At^{-n}$. One subject cleared 80% of his initial respiratory tract burden during the first day; the second cleared 89% of his burden. Based on the recent lung model of the ICRP, integral lung doses for the two subjects were calculated to be 6.8 rad and 2.2 rad; lower large intestine doses resulting from early rapid clearance were 3.1 and 2.2 rad. (auth)

14178 EARLY ASSESSMENT OF THE SERIOUSNESS OF LUNG CONTAMINATION BY INSOLUBLE ALPHA AND LOW-ENERGY BETA EMITTING MATERIALS AFTER INHALATION EXPOSURE. Lister, B. A. J. (Atomic Energy Research Establishment, Harwell, Eng.). pp 1191-8 of Radiation Protection. Part 2. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

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After inhalation of γ- and high energy β-emitting materials, the lung content can be measured by direct in vivo counting methods. For materials with less penetrating radiation this approach is not possible (except perhaps to give an upper limit) and indirect information, such as that from measurements on excreta and examination of air sample papers, must be used to make an assessment of lung content. The usefulness of such indirect information is reviewed and ways in which it can be used to arrive at the best estimate of lung burden are suggested. Data from some relevant inhalation incidents illustrate the points made. (auth)

14179 MEASUREMENT AND MANAGEMENT OF INSOLUBLE PLUTONIUM–AMERICIUM INHALATION IN MAN. Brodsky, A. (Univ. of Pittsburgh); Sayeg, J. A.; Wald, N.; Wechsler, R.; Caldwell, Roger. pp 1181-90 of Radiation Protection. Part 2. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

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A drybox explosion on January 17, 1966, exposed three individuals to inhalation of dust containing a mixture of ^{239}Pu and ^{241}Am. Preliminary measurements at the University of Pittsburgh whole-body counter 27 hr after the incident, using a 1 mm thick, 2 in. D, NaI detector indicated a possible lung burden as high as 0.4 μCi ^{239}Pu in one of the individuals. Although a considerable fraction of the contamination was believed to be ^{241}Am, upper-limit estimates of ^{239}Pu in the lung were still as high as 0.24 μCi on day 4 (post-exposure), so the decision was made to administer 1 g/day DTPA intravenously for the next three days. On day 5, a hundred-fold increase appeared in the count-rate and changes occurred in the spectral shapes indicating a sudden appearance of new surface contamination on the anterior chest. This activity, as well as its probable source (another spot of contamination found on the forehead) was removed. Subsequent spectral shapes indicated that further measurements were indicative of lung radioactivity. Isotopic analyses of contamination and air samples showed that the major fraction of the activity was ^{241}Am. Interim estimates of lung burden were then: 7×10^{-3} μCi of ^{241}Am on day 4; 4×10^{-3} μCi on day 11; 6×10^{-4} μCi on day 28; and 4×10^{-4} μCi on day 57. These values are consistent with the elimination of about 36,600 d/min of ^{241}Am and 54 d/min of ^{239}Pu in the first fecal sample. Urine excretion rates, initially less than 0.4 dpm/24 hr, increased 50 to 100 times between days 5 to 8, suggesting the efficacy of DTPA in removing insoluble ^{241}Am from the lung. (auth)

14180 AIRBORNE IODINE MONITORING AT THE RADIOISOTOPE TEST PRODUCTION PLANT, JAERI. Fukuda, S.; Naritomi, M.; Izawa, S.; Izumi, Y. (Japan Atomic Energy Research Inst., Tokai). pp 1153-66 of Radiation Protection. Part 2. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

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During production of ^{131}I from an irradiated telluric acid (H_2TeO_4) by the distillation method, a considerable amount of airborne radioiodine is generated in the cell and its major portion is discharged to the atmosphere through a stack after passing through air cleaning systems, consisting of prefilters, charcoal filters, and high efficiency particulate filter. Some minor portion of airborne iodine generated leaks directly out of the cell to the service area and operation area, although a negative pressure is maintained in the cell. To evaluate the airborne iodine concentration in air and the amount discharged as accurately as possible, extensive radiation monitoring was performed using various kinds of monitoring devices. As one of these devices, an iodine sampler was developed which is composed of three sampling components, i.e., HV-70 filter paper, charcoal-impregnated filter paper and charcoal cartridges. At several sampling positions of the air cleaning systems, the overall collection efficiency of the sampler was evaluated by taking into account activities collected in cold traps (containing granular charcoal) which are connected to the sampler in series. It was found that the overall collection efficiency ranges from 70% to 100%, highly dependent on whether the samples were taken at upper stream or downstream of the air cleaning systems. Data obtained from the airborne iodine monitoring at the stack and in the working areas conducted during the ^{131}I test production are presented, and internal exposures of the operating personnel received by inhaling the airborne iodine are described in relation to the air contamination of the working areas. (auth)

14181 PERSONNEL MONITORING AROUND THE CERN HIGH-ENERGY ACCELERATORS. Dutrannois, J.; Baarli, J. (CERN, Geneva). pp 1139-45 of Radiation Protection. Part 2. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

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The present methods of personnel monitoring applied near the CERN high-energy accelerators are reviewed. This includes the technical as well as the administrative procedures in use. Results of statistical analyses of the data are presented, discussed, and compared with data obtained from radiation survey measurements. The apparent limits of validity of the system are deduced and discussed with a view of possible improvements. (auth)

14182 PREOPERATIONAL SEARCH FOR BASELINE RADIOACTIVITY, CRITICAL FOOD, AND POPULATION GROUP AT THE TARAPUR ATOMIC POWER STATION SITE. Kamath, P. R.; Bhat, I. S.; Khan, A. A.; Ganguly, A. K. (Preoperational Environmental Survey Lab., Tarapur, India). pp 1111-25 of Radiation Protection. Part 2. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

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Two reactors, each of 200 MW(e), are under construction at Tarapur, 100 km north of Bombay on the west coast. A pre-operational environmental survey laboratory was set up in 1964 to carry out environmental investigations and research. In the first phase of the pre-operational program, 45 monitoring stations were established in the 0 to 32 km region from the station and nearly 1200 environmental samples were examined for natural and fallout radioactivity and trace element content. Information on social habits of people, land utilization, and dietary habits was collected during the survey trips. In the near zone (0 to 8 km) of the reactors, detailed information on dietary items and food consumption were collected from 100 families belonging to different professions and socio-economic groups. Applying the data obtained from assays of environmental samples and demographic surveys, an attempt is made to predict the possible critical food and critical group of population in the region. In the Indian diet, most of the fallout contamination is obtained from cereals (predominantly from rice). Exposure from activation products is likely through intake of fish harvested from shore waters. ^{90}Sr/Ca ratios in Tarapur and New York diets are surprisingly in close agreement. However, Ca in N.Y. diet comes from milk, fish, and meat whereas in Tarapur diet it comes from cereals and vegetables. The same observation applies to the availability of P in the two diets. It is observed that the fishing population in the area could be the critical group in the environment under normal operating conditions. (auth)

14183 CONTAMINATION WITH ^{210}Po, URANIUM, AND ^{226}Ra DUE TO SMOKING. Kilibarda, M.; Petrovic, D.; Panov, D.; Djuric, D. (Inst. of Occupational Health, Belgrade). pp 1099-1103 of Radiation Protection. Part 2. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

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The content of ^{210}Po, ^{226}Ra, and uranium has been examined in well-known Yugoslavian cigarettes and in tobaccos from regions of Yugoslavia where the best tobacco is produced. Simultaneous measurements were made of the content of these nuclides in the urine of smokers and non-smokers. The distribution of ^{210}Po in smoke, ash, and cigarette stubs as a function of combustion temperature was studied. Values of ^{210}Po in cigarettes ranged from 0.4 to 0.6 pCi/g, ^{226}Ra below 10^{-12} Ci/g and uranium was less than 5γ/g of cigarette. Analysis of the distribution of ^{210}Po has shown that about 40% is found in smoke. The urinary ^{210}Po values in smokers and non-smokers are different, but there is no significant statistical difference between them. (auth)

14184 ^{210}Po IN ITALIAN TOBACCO. Carfi, N.; Dugnani Lonati, R. (Laboratori CISE, Milan). pp 1097-8 of Radiation Protection. Part 2. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

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It is known that ^{210}Po contained in tobacco is volatile at the temperature of a burning cigarette. Hence a radiation hazard from ^{210}Po may arise for a smoker's bronchial epithelium. Hence measurements of ^{210}Po were started in most popular Italian cigarettes. A later stage of the work will consider the tobacco from some Italian regions. Polonium was extracted from tobacco samples by a wet ashing procedure and plated on nickel discs. The discs were mounted on ZnS phosphors and the alpha activity was counted. The polonium alpha spectrum was measured by an ionization chamber. The method can be simply carried out, but difficulty arises from the low-background alpha counting necessary for determining accurately the minute quantities of ^{210}Po (of the order of 10^{-2} pCi). (auth)

14185 ^{226}Ra AND THE NATURAL AIRBORNE NUCLIDES ^{210}Pb AND ^{210}Po IN ARCTIC BIOTA. Holtzman, Richard B. (Argonne National Lab., Ill.). pp 1087-96 of Radiation Protection. Part 2. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

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In order to better determine the characteristics and effects on humans of arctic biota with high concentrations of ^{210}Pb and ^{210}Po, these nuclides, along with their long-lived predecessor, ^{226}Ra, were measured in lichens, in bone and muscle of caribou and other arctic animals, and in Eskimo placenta. ^{226}Ra, with concentrations $1/3$ to $1/50$ those of the other nuclides, cannot be the direct source of the other nuclides. In caribou bone the ^{210}Po was in radioactive equilibrium with the ^{210}Pb and averaged about 11.7 pCi/g ash, twice the ^{210}Pb in reindeer bone. The ^{210}Pb content of muscle of both species was 10 pCi/kg (wet). By contrast, the ^{210}Po content was much greater, about 200 pCi/kg. A definite seasonal decrease was noted in the ^{210}Pb in muscle during the second half of the year. Similar variations were indicated for ^{210}Po in muscle and for ^{210}Pb in bone. The high levels in caribou are attributed to the high fallout levels of these nuclides in lichens, their winter forage, which contain (in dry weight) 6 pCi ^{210}Pb/g and 12 pCi ^{210}Po/g. The other animals exhibited appreciably lower concentrations in bone and muscle. Wolf, which consumes large quantities of caribou, exhibited activities in bone of 1 pCi/g ash, about that observed in some Eskimo bone by Hill. The ^{210}Po content of wolf muscle was about the same as that of caribou, 200 pCi/kg, but the ^{210}Pb was only about 1 pCi/kg. Similar, but less dramatic, differences were observed in Eskimo placenta. Estimates of uptake show that Eskimos could acquire sufficient of the long-lived ^{210}Pb to double the total skeletal radiation dose (rad) over that of Midwesterners. However, despite the high concentrations of the ^{210}Po in meat, direct intake accounts for only a relatively small increase in total dose. (auth)

14186 ON THE VARIATION OF THE LEVELS OF ^{90}Sr AND OTHER FALLOUT NUCLIDES IN THE GRAIN OF RYE, BARLEY, WHEAT, AND OATS. Aarkrog, A. (Danish Atomic Energy Commission, Risoe). pp 1065-81 of Radiation Protection. Part 2. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

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The predominant influence of cereal grains as a ^{90}Sr donor (and a ^{137}Cs and ^{54}Mn donor as well, in certain years) in total Danish diet has stimulated the present investigation. A country-wide collection of grain samples has been carried out in the years 1959-64 at a number of selected state experimental farms. Along with the grain sampling, data on ^{90}Sr in air, soil, and precipitation have been collected. Analysis of variance shows that rye contained more ^{90}Sr, ^{137}Cs, and ^{54}Mn than barley or wheat or oats. It is demonstrated that awns and, to some degree, grain size play an important role in the direct contamination of grain. The variation between locations, as regards ^{90}Sr levels in grain, depended upon the amounts of precipitation and, to some degree, on the calcium level and the stable strontium to calcium ratio of the soil. The variation between years followed the ^{90}Sr activity in air in August and the amount of precipitation in this month. Winter and spring varieties of rye and wheat did not differ significantly in ^{90}Sr and ^{137}Cs contents. The uptake of ^{54}Mn in cereals related to the fallout rate rather than to the accumulated fallout. By multiple regression analysis it is shown that the pCi ^{90}Sr/g Ca level for the years 1959-64 in the different species of Danish grain considered separately can be described by equations of the type: pCi $^{90}Sr/g\ Ca = k^0 \cdot A^{k_1} \cdot B^{k_2} \cdot C^{k_3}$ where A, B, and C, respectively, represent mm precipitation in August, pCi $^{90}Sr/m^3$ air in August and accumulated mCi $^{90}Sr/km^2$ in soil by September; k_1, k_2, and k_3 are the respective partial regression coefficients. (auth)

14187 FIVE YEARS EXPERIENCE OF ^{90}Sr AND ^{137}Cs HERBAGE TO MILK TRANSFER UNDER FIELD CONDITIONS. de Bortoli, M. (EURATOM, Ispra, Italy); Gaglione, P.; Malvicini, A.; Van der Stricht, E. pp 1053-63 of Radiation Protection. Part 2. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

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Routine radioactivity measurements on grass and milk are

performed as part of the radiological monitoring program of the Euratom Ispra Establishment. Herbage samples are collected monthly from May to October in six stations; milk is sampled weekly in four small dairies and the pooled monthly samples analyzed. The ^{90}Sr and ^{137}Cs contamination found hitherto is due to the world-wide fallout, whose rate has changed considerably during the period 1961 to 1965. This fact has enabled the study of the transfer of the two radionuclides from grass to milk, under conditions of both direct and indirect prevailing contamination. Particular consideration has been given to the ^{90}Sr milk-herbage observed ratio which has been found rather constant from year to year at a value of about 0.16. The same does not hold for the ^{137}Cs observed ratio which ranges from 0.9 to 1.7. The $^{137}Cs/^{90}Sr$ ratio in herbage shows relatively large variations, if compared to the same ratio in fallout. These variations, however, reflect the different behavior of the two nuclides in the transition fallout/herbage, yielding high values of the ratio during periods of high fallout rate (direct contamination predominant) and low values in the periods of low fallout rate (uptake from the soil prevailing). The same trend is observed in milk. (auth) (C.O.)

14188 DETECTION AND MEASUREMENT OF PLUTONIUM CONTAMINATION IN WOUNDS. Jones, E. W.; Saxby, W. N. (Atomic Weapons Research Establishment, Aldermaston, Eng.). pp 1295-1307 of Radiation Protection. Part 2. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

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Plutonium is extensively used in atomic research and industry and inevitably there occur wounds and injuries which contain plutonium. Because of its high toxicity it is important to identify, locate and measure any plutonium present. At levels which have medical significance, the quantities involved are minute, but there is sufficient emission of accompanying x and γ radiations to permit identification and assay by radiometric techniques. X rays in the band 13 to 20 keV, γ rays of about 60 keV and γ rays of about 384 keV can all be used for this work: the problems and the limitations associated with measurements in these three energy bands are discussed, including the usefulness of energy spectrometry to eliminate errors due to self absorption. There are various instruments available, and usable, for radiometric determinations of plutonium in wounds. Several of these are described with their limitations and detection capabilities. A case of a contaminated wound is quoted to illustrate some of the techniques and problems in the assessment of plutonium content. Some subsequent work undertaken to improve identification and measurement is also described. A number of specific actions are suggested, which should be taken, following the occurrence of a wound to ensure that any plutonium present before and after medical treatment is correctly identified and measured. (auth)

14189 ON THE EXTENT OF X-RAY EXAMINATIONS IN FINLAND. Isola, Aulis (Inst. of Radiation Physics, Helsinki). pp 1321-4 of Radiation Protection. Part 2. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

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The annual genetically significant dose of the Finnish population from 2,716,900 x ray examinations and 80,000 dental exposures carried out in 1963 has been calculated to be 16.8 mrem. The male, female, and fetal contributions to this dose were respectively 4.2 mrem, 8.7 mrem, and 3.9 mrem. The high female contribution observed here is largely due to pelvimetry, hysterosalpingography, obstetrical abdomen, and lower gastrointestinal tract procedures, for which the male contribution only amounts to 5.6% although these examinations account for 42.5% of the total genetic dose. Scrutiny of the contributions of various examinations to the total genetic dose reveals that abdomen and lower gastrointestinal tract account for 26.1% of this dose. Chest surveys cause 6.9% of the genetic dose. This remarkably high proportion is largely due to the fact that approximately 11% of the Finnish population undergoes this survey annually. Although the frequency of mass miniature radiography was very high, about three persons out of ten undergoing this survey annually, its contribution to the genetic dose was found to be not more than 0.9%. (auth)

14190 PHARMACEUTICAL AND RADIATION HYGIENE PROBLEMS IN RELATION TO RADIOPHARMACEUTICALS. Kristensen, Knud (National Health Service of Denmark, Copenhagen). pp 1317-19 of Radiation Protection. Part 2. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

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Preparation, distribution, storage, and use of radioactive pharmaceuticals involves a number of pharmaceutical and radiation hygiene problems. In recent years these have been emphasized by the rapidly increasing use of this type of drug. A study of radiation hygiene and pharmaceutical aspects of radiopharmaceuticals has underlined the possible conflict between radiation-hygiene and pharmaceutical viewpoints. A close cooperation between experts representing radiation hygiene and pharmacy is therefore considered of utmost importance. In view of the rapid development of nuclear medicine it is likewise of great importance to furnish an up-to-date service for the clinician from both these fields. In Denmark it has been proposed that we establish a Pharmaceutical Isotope Laboratory ("Isotope Pharmacy"), which should assume the responsibility that all radiopharmaceuticals are of satisfactory quality, e.g., by purchasing, controlling and distributing radioactive drugs. (auth)

14191 PHYSIOLOGICAL CONDITIONS IN PRESSURIZED SUITS: EVALUATION AND CONTROL OF THERMAL STRESS. Rowlands, R. P. (United Kingdom Atomic Energy Authority, Harwell, Eng.). pp 1325-32 of Radiation Protection. Part 2. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

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The thermal conditions experienced by the wearer of a pressurized suit are described by an "index of thermal stress." The value of this index depends on the temperature, humidity and flow rate of the breathing air supplied to the suit, the man's metabolic heat production which depends on his rate of energy expenditure, and the thermal conditions of the workplace outside the pressurized suit. Formulae are given which relate these parameters so that the index can be evaluated for a given pressurized suit operation. A third formula is given which predicts likely sweat rates. Other physiological responses such as body temperature and heart rate are related to the value of the index of thermal stress. It is convenient to group values of the index into four zones, representing conditions which are physiologically comfortable, tolerable, barely tolerable or intolerable. Control charts, based on the formulae, enable breathing air supply rates to be decided for these conditions after objective consideration of operational factors such as the duration and nature of the work task, the need for rest pauses and thermal conditions in the pressurized suit facility. The thermal stress on the man is thereby controlled and his physiological responses kept within acceptable limits. (auth)

14192 REMOVING RADIOACTIVITY FROM MILK. Terrill, James G. Jr.; Bales, Ronald E.; Hickey, John L. S. (Public Health Service, Washington, D. C.). pp 1353-67 of Radiation Protection. Part 2. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

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The need for measures to reduce public exposure to environmental radiological contamination from accidents and fallout has led to a program of research, development, field testing and operations by the Public Health Service in the United States over a period of several years. This effort has now been focused to form a consistent pattern under the guidance of the Federal Radiation Council. Laboratory, field sampling, and evaluation experiments related to radioactive iodine will be presented. The data from various research investigations useful to operating agencies in the benefit-risk decisions will be described. The research, development, and large-scale testing of methods for concurrently removing anions and cations from milk during processing will be described including presentation of data from both laboratory and large-scale experiments. Cost data related to some large-scale experiences will be given where it would be useful for comparative purposes. Presently, for example, the work indicates that a ^{90}Sr removal process alone will add approximately 2 cents per quart to the cost of milk. Indicators of possible ways to reduce this cost by combining control procedures, such as for ^{131}I and ^{90}Sr, will be given. The administrative procedures used to initiate each phase of the laboratory research, development, and field evaluations of these systems will be described. (auth)

14193 ESTIMATION OF RADIATION PROTECTION GUIDES: INTERSPECIES CORRELATIONS. Richmond, C. R.; Furchner, J. E. (Los Alamos Scientific Lab., N. Mex.). pp 1417-31 of Radiation Protection. Part 2. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

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Values recommended for maximum permissible concentration (MPC) of radionuclides in air and water and for retention by the body and its component tissues are commonly based on data obtained from acute tracer studies in rodents. Conceptually, however, conditions of chronic exposure for human subjects are embodied in MPC calculations. Unfortunately, studies on retention of many radionuclides by human subjects are impossible or impracticable, even though the development of ultrasensitive human counters represents a significant contribution to the problem. Metabolically speaking, a 70-kg mouse or rat is sometimes regarded as a standard man. One approach to resolving this problem is to find interspecies correlations in radionuclide metabolism and ways of extrapolating to MPC values for man. During continuous ingestion of a constant amount of a material, an equilibrium level may be reached within the body. This level is predictable from acute administration studies. The integral of the effective retention function (limits of zero to infinity) is proportional to equilibrium level and has dimensions of multiples of the daily intake. The integral is also proportional to radiation dose. Interspecies correlations of the form $E = aX^b$, which relate equilibrium levels (E) obtained for mice, rats, dogs, monkeys, and men to grams body weight (X), have been developed for tritium water (HTO), ^{22}Na, ^{54}Mn, ^{65}Zn, ^{86}Rb, ^{131}I, and ^{137}Cs. The proportionality constant b differs for each element. In each case, values obtained directly from human studies agree well with values for man derived from the correlation. Equilibrium levels as a function of body surface, body weight, and metabolic rate using the power function (with and without the log transform) and a first-degree polynomial were also considered as models. The polynomial relating equilibrium level to body surface best describes cesium metabolism and accounts for shorter turnover times observed in children. (auth)

14194 CLASSIFICATION OF RADIONUCLIDES ACCORDING TO THEIR RELATIVE TOXICITY. Gairon, P.; Feige, Y. (Soreq Nuclear Research Centre, Yavne, Israel). pp 1407-16 of Radiation Protection. Part 2. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968. (In French).

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Every classification of unsealed radioactive nuclides according to their relative toxicity depends on the units employed. In addition to the activity (expressed in μCi), the weight (in μg), and the number of radioactive atoms (N) have served as criteria to evaluate the relative toxicity of radioactive isotopes. Some authors have derived formulas permitting the calculation of the maximum permissible concentration in air (MPC_a) using the specific activity ($\mu Ci/\mu g$) as a weight function in order to reflect to a certain extent the classification both according to the activity and to the weight. In order to establish the maximum permissible quantities in the body, a table is proposed classing the radionuclides according to the comparison of these two classifications. This table superposes a shading code on a two-dimensional graphic representation; the two classifications are thus maintained intact while illustrating the practical restrictions encountered in using one or the other exclusively. Every bidimensional representation is still incomplete and other classifications can be deduced by the coupling of parameters chosen from these four or more which appear in the toxicity formula. One advantage of the method presented resides in the possibility of extending its application to other toxic compounds, even non-radioactive compounds, and of allowing the quantitative evaluation of the risks when there is simultaneous danger of radioactive and chemical contamination. (tr-auth)

14195 A QUANTITATIVE ESTIMATION OF THE HAZARDS INVOLVED IN WORK WITH RADIONUCLIDES. Franke, Th.; Herrmann, G.; Hunzinger, W. (European Company for the Chemical Processing of Irradiated Fuels, Mol, Belg.). pp 1401-6 of Radiation Protection. Part 2. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

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The damage caused to the critical organ by accidentally incorporated radionuclides is taken as a quantitative measure of the hazard associated with those radionuclides. If the damage itself is assumed to be proportional to the dose equivalent, then the hazard is the product of: the total amount of radioactivity handled, the dose equivalent to the critical organ after a single intake of one unit of radioactivity, and the incorporated fraction of the total activity handled. The first two factors require no particular discussion. For the third factor it is assumed that the accidental intake is by inhalation. Because a derivation of a quantitative figure for this factor is not possible, a statistical investigation of accidents that have already occurred has been started. The accidental inhalations have been classified according to different characteristics of the operations: type of ventilation, physical state, temperature, etc. The preliminary results show that it is possible to obtain average figures for the inhaled fraction of the total activity handled during specified operations. The figures lie almost within one order of magnitude and are independent of the type of accident. The knowledge of these figures permits either the hazard or the maximum permissible quantities of radioactive material to be handled to be derived quantitatively. (auth)

14196 DECONTAMINATION OF FISSION PRODUCTS ON HUMAN SKIN AND HAIR. Nishiwaki, Yasushi; Nishioka, Hajime (Tokyo Inst. of Tech.). pp 1499-1508 of Radiation Protection. Part 2. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

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The contamination and decontamination of human skin and hair may be influenced not only by the colloidal adsorption on the surface or absorption of radioactive substances into human tissue, but also by various physical, chemical and biological factors which make a reproducible decontamination experiment difficult. Therefore, in order to compare the efficiencies of various decontaminating agents we have employed a special device with which the conditions of decontamination could be kept more or less constant. In these experiments, water, citric acid and the powerful chelating agents EDTA and DTPA were used for the purpose of decontamination of fission-products on a non-living, human skin sample and on hair. The decontaminated percentage (D_t), expressed in total gross activities, and the change of the decontaminated radioactivities per unit volume of eluting solution were measured. Judged on the basis of the decontaminated percentage (D_t), the chelating agents were similarly effective in decontaminating the samples of human skin as with those of human hair. The radioactivities rapidly removed in the initial eluting solution seemed to indicate that there was a component that can be easily decontaminated with the chelating agents. The persistently remaining activity appearing in the eluting solution after elution with 300 to 400 ml seemed to indicate that some of the strongly fixed or reacted component might have been gradually eluted out with the chelating agents. The decontaminated percentage (D_n) of each nuclide as estimated by the analysis of the γ-spectrum is given to show an order of magnitude. The similarity in the mode of decontamination between the samples of human skin and those of hair may indicate, at least partly, the possibility of the existence of a competing effect of chelating agents against some of the reactions between metals in fission-products and proteins, for instance, keratin, collagen and so on which exist commonly in both samples. Although it is anticipated that the use of chelating agents may enhance the absorption of some radioactive nuclides through the skin, if the solution containing the chelating agents were used for the decontamination of skin and hair in the form of a shower or by running water over the contaminated skin or hair to minimize the skin absorption, it may be extremely useful in some cases. (auth)

14197 EFFECTS OF PHANTOM GEOMETRY ON DOSE DISTRIBUTION. Neufeld, Jacob; Anderson, V. E.; Wright, Harvel; Snyder, W. S.; Turner, J. E. (Oak Ridge National Lab., Tenn.). pp 1469-72 of Radiation Protection. Part 2. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

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Calculations have been made of the spatial distribution of dose and dose equivalent due to protons of energies 250 MeV and 400 MeV incident on a tissue phantom which has dimensions approximating those of a human torso and has the form of a right elliptical cylinder with a height of 70 cm and with semiaxes of the elliptical base as 20 cm and 10 cm. The results obtained have been compared with the corresponding data previously obtained for a tissue slab having thickness of 30 cm. It is shown that within the limits of accuracy due to statistical fluctuations the distribution of dose and dose equivalent are not substantially different in a cylindrical phantom from the corresponding values in a slab phantom. (auth)

14198 ARGUMENTS FOR THE ESTABLISHMENT OF STANDARDS FOR INERT RADIOACTIVE GAS. Goussev, N. G.; Kotchetkov, O. A.; Mikhailov, L. M.; Tourkine, A. D.; Troukhmanova, E. S.; Philipovitch, V. P. pp 1445-53 of Radiation

Protection. Part 2. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968. (In French).

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Up to the present the standards of inert radioactive gases (IRG) of the isotopes such as Ar, Kr, and Xe were defined by establishing their maximum permissible concentrations (MPC) in the air of work sites and in the atmosphere of localities. In agreement with the recommendations of the ICPR the MPC is determined in this case according to the external β, γ radiation that one person receives if he is surrounded by an infinite hemispheric cloud of IRG. It is shown in the present report that in the case of release of IRG by the ventilation tube in the propagation direction of the cloud there is no strict agreement between the inert gas concentration in the air layer at ground level and the calculated dose of external γ radiation. This is why the establishment of the norms of the isotopes Ar, Kr, and Xe in atmospheric air should not be made according to the MPC but according to the yearly dose of external γ radiation produced by the cloud of radioactive gases at the surface of the earth. In this case, the maximum permissible release I, Ci/unit of time represents the principal controllable magnitude. In the air of work locations, the establishment of the norms is made according to the MPC, but in the calculation formulas it is necessary to take into consideration the volume limits of the room and the fact that the irradiation danger, practically, is determined completely by the radiation field of β particles and conversion electrons. (tr-auth)

14199 PRACTICAL PROBLEMS IN THE APPLICATION OF RADIATION PROTECTION STANDARDS IN THE FIELD OF PUBLIC HEALTH. Blatz, Hanson (New York University Medical Center. New York City Office of Radiation Control). pp 1439-44 of Radiation Protection. Part 2. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

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The growth of the nuclear age has been rapid, and enlightenment about the biological effects of radiation has followed. To protect ourselves, a wide variety of standards, recommendations, guides, laws and regulations has evolved. They were naturally first developed by those using radionuclides and machines producing ionizing radiation. They were then the only persons with knowledge of such matters. Now that public health agencies are rightfully assuming more of the responsibility for this new and growing public health problem, they find that they have inherited many established standards and rules formulated by authors who lacked experience in public health administration. Standards and rules are often inconsistent with public health tradition (which in some respects may not be bad), and in many cases difficult, if not impossible, to administer adequately within the framework of most public health agency resources and personnel. (auth)

14200 THE FEDERAL RADIATION COUNCIL: ITS RESPONSIBILITIES AND ACTIVITIES. Palmiter, C. C. (Federal Radiation Council, Washington, D. C.). pp 1435-7 of Radiation Protection. Part 2. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

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A brief historical review of the role of government in radiation protection is given, and events leading to the establishment of the Federal Radiation Council are traced. Some of the problems and some of the benefits that have developed from the creation of the Federal Radiation Council which serves as a forum where all considerations can be brought together to establish and recommend to the President a national policy on radiation protection are described. (auth) (C.O.)

14201 DECONTAMINATION OF SKIN CONTAMINATED EXPERIMENTALLY BY A MIXTURE OF FISSION PRODUCTS AND BY SYNTHETIC FALLOUT. Stajic, J. S.; Stojanovic, D. B.; Milovanovic, A. V. (Boris Kidric Inst. of Nuclear Sciences, Vinca, Yugoslavia). pp 1509-17 of Radiation Protection. Part 2. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968. (In French).

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The efficiency of the radiodecontamination of the skin of animals experimentally contaminated by mixtures of long-period fission products dissolved in the nitrate form and by mixtures of average-period fission products dissolved in the chloride form was examined. The soluble decontaminants in tap water, the solube decontaminants in sea water, the classic decontaminants whose utilization is preceded by the application of a protective cream, and the materials for decontamination with use of water were tested. The results obtained indicate that the majority of the materials can eliminate efficiently from the skin the liquid mixtures of fission products (over 95% after four treatments). Similar results, perhaps even better, were obtained when the contaminant was a synthetic fallout (radioactive powder artificially labeled with ^{141}Ce). The efficiency of the decontamination of hairy skin, contaminated with liquid contaminants, was also examined. The effect obtained was relatively satisfactory. (tr-auth)

14202 RADIATION SAFETY PROBLEMS CONNECTED WITH THE MEDICAL USE OF RADIOISOTOPES. Cloutier, R. J.; Dalton, C. P. (Oak Ridge Associated Universities, Inc., Tenn.). pp 1603-13 of Radiation Protection. Part 2. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

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More than 3800 physicians and medical institutions in the United States use radioisotopes in diagnosis, therapy, and research. A review is given of the connected radiation protection problems: techniques of administering radioactive drugs, control of radiation and contamination hazards to hospital personnel and visitors, criteria for release of radioactive patients from a hospital, autopsies of radioactive cadavers, and the radiation safety training of a hospital staff. The problems are not completely solved. More thought, research, and communication among professional health physicists are needed to speed the work that remains to be done. (auth)

14203 NEW TECHNIQUE FOR FULL RADIATION PROTECTION OF PERSONNEL IN TELECOBALT TREATMENTS. Bozoky, L. (National Inst. for Oncology, Budapest). pp 1597-1601 of Radiation Protection. Part 2. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

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The construction of a special cobalt unit designed for moving-field therapy is described. The most important characteristic of the apparatus is that when switched off, at any point of the treatment head as well as the surrounding area, only natural background radiation is measurable. The apparatus can be safely operated even in the absence of electric current. Some results of the radiation protection measurements are discussed. (auth)

14204 RADIATION SAFETY HAZARD OF CHLORMERODRIN. Johnson, Philip C.; Wade, Leo (Methodist Hospital, Houston, Tex. Baylor Univ. College of Medicine, Houston, Tex.). pp 1593-6 of Radiation Protection. Part 2. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.2)).

Not usually appreciated is the tendency of organic compounds containing radioactive mercury to release mercury vapor in amounts large enough to cause significant radioactive contamination of laboratory areas and to pose a possible radiation hazard to employees working in these areas. This is a particular hazard in medical radioisotope laboratories where chlormerodrin, ^{203}Hg, is used in large quantities for scanning of the brain and kidneys. At room temperatures, release of mercury occurs continuously from commercial solutions of radioactive chlormerodrin prepared for human use. While the release rate is variable from bottle to bottle, we have found multi-injection bottles containing 5–15 mCi of chlormerodrin which release, even before the top has been punctured by a needle, 22.5 $\mu\mu$Ci ^{203}Hg/24 hr. Release was measured by placing a beaker of trichloracetic acid into a closed jar containing a vial of radioactive chlormerodrin. Release of mercury vapor could be increased by alkalinization. Vaporization was decreased by acidification and the addition of weak protein solutions to the bottle of chlormerodrin. Areas in which this compound are used or prepared show significant contamination with mercury not only in areas accessible to liquid spillage but also in exhaust ducts and on ceilings. Because of its long half-time, progressive build-up of ^{203}Hg was found to occur in our radioisotope laboratory. This occurs particularly on containers used to store chlormerodrin bottles and in the storage hood. The high absorption of mercury into glassware sets the stage for later release of mercury from bottles during storage for radioactive decay. The methods we developed for controlling this hazard will be discussed. (auth)

14205 HOSPITAL RADIUM ACCIDENT. Berg, Ole; Kristensen, Knud; Grande, P.; Madsen, C. B. (National Health Service, Copenhagen. Radium Center, Arhus, Denmark). pp

1585-9 of Radiation Protection. Part 2. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.2)).

Uncontrolled spread of radium from a damaged radium tube resulted in extensive building contamination. There was no serious contamination of personnel. Decontamination work and the measurement of internal contamination of personnel is described. (auth)

14206 A NEW APPROACH TO THE REDUCTION OF INHALATION DOSE IN WORKING AREAS USING MOBILE ELECTROSTATIC PRECIPITATORS. Vohra, K. G.; Nair, P. V. N. (Bhabha Atomic Research Centre, Bombay). pp 1569-73 of Radiation Protection. Part 2. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.2)).

A system for the rapid continuous decontamination of air has been investigated for reducing the inhalation dose in working areas where continuous small releases of radioactive contaminants in the air are unavoidable due to the nature of the operations involved. Continuous replacement of conditioned air used in such areas with the atmospheric air is generally not feasible due to large differences between the temperature of the conditioned air and the atmospheric air. Consequently recirculation has to be employed. Recirculation through the filters in the air conditioning system generally does not remove a large fraction of the submicron particles which are mainly responsible for the dose to the lung. The system described in this paper is based on a mobile electrostatic precipitator which can remove the particulate matter from the air down to the submicron size range at large flow rates. A description of the electrostatic precipitator used for continuous decontamination of the air, and studies carried out with the system in a test room and in typical working areas are presented. (auth)

14207 UNRESOLVED PROBLEMS ASSOCIATED WITH EVALUATION OF TISSUE DOSE FOR THE THOROTRAST PATIENT GROUP. Hursh, John B. (Univ. of Rochester School of Medicine and Dentistry, N. Y.). pp 1525-30 of Radiation Protection. Part 2. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.2)).

With the intent of enabling a more precise specification of radiation dose to Thorotrast-injected patients, a study has been made of the physico-chemical properties of Thorotrast solutions. This study has focussed on the tendency of ^{232}Th daughters to adsorb on glass of the vials in which Thorotrast is dispensed by the manufacturer. It has been found that 50 to 90% of ^{228}Ra and ^{228}Th daughters adsorb when ultracentrifugation experiments show them to exist as polymers in the solution. It has not been possible to relate the tendency to form aggregates to pH, age of the solution, or concentration of the daughters. It is shown by calculation that the maximum uncertainty of radiation dose (15-year interval of exposure) may be as much as 50 per cent due to inability to specify the daughter content of the injected Thorotrast. (auth)

14208 MEASUREMENT AND CHARACTERISTICS OF DEPTH-DOSE PATTERNS DUE TO PROTON BEAMS. Baily, Norman A. (Emory Univ., Atlanta); Frey, Harvey S. Health Phys., 16: 349-58(Mar. 1969).

The absorbed dose to a particular organ or region of the body of an irradiated animalor human by a beam of high-energy protons depends upon such factors as the organ or region under consideration, beam geometry, material through which the beam has passed prior to incidence on the subject considered, and other factors which may be peculiar to any pertinent situation. Of particular concern are regions in which rapid dose buildup may take place. A computer program was designed to utilize experimental depth-dose data to produce isodose curves in selected geometrical figures and under specific radiation geometry. These curves were computed for proton energies between 45.8 and 730 MeV in both circular and elliptical tissue-equivalent cylinders uniformly irradiated about their axis by a proton beam, the flux of which was uniform along the cylinder axis and perpendicular to it. The effect of passage through large thicknesses of copper or carbon and then air, before incidence on the cylinder, were investigated. The implications for physical dosimetry in the light of the isodose patterns produced are discussed. (auth)(UK)

14209 LOCAL ENERGY DENSITY IN THE CASE OF AN INCORPORATED α-EMITTING NUCLIDE. Kappos, A. D., Rajewsky, B. pp 188-93 of Molekulare Struktur und Strahlenwirkung. Glubrecht, H. (ed.). Stuttgart, Georg Thieme Verlag, 1968. (In German).

From Annual Meeting of the Molecular Structure and Radiation Effects, Hanover, Ger. See CONF-660671.

For a quantitative description of the damage caused in the case of an incorporated α emitting nuclide, the magnitude Z, the local absorbed energy in a biological unit distributed through the mass of this biological unit, was applied. Z was evaluated and some typical results of the calculation were given. The agreement of these calculations with the Spiers model for the microdosimetry of α emitting nuclides in bones is discussed. (J.S.R.)

14210 INVESTIGATION OF FLUCTUATION RANGES IN NATURAL ENVIRONMENTAL RADIATION. Keil, R. A. pp 220-9 of Molekulare Struktur und Strahlenwirkung. Glubrecht, H. (ed.). Stuttgart, Georg Thieme Verlag, 1968. (In German).

From Annual Meeting of the Molecular Structure and Radiation Effects, Hanover, Ger. See CONF-660671.

The construction of a gamma beam spectrometer in the Radiological Mobile Unit of the Max Planck Institut fuer Biophysik in Frankfurt am Main is described. Its applicability as well as its advantages and disadvantages with respect to other measurement methods as counters and ionization chambers are explained using measurements found with the spectrometer. Various methods for the determination of the dose output from pulse-height spectra are discussed and the errors are given. On the basis of the results of measurements carried out at various sites in Frankfurt and its vicinity the fluctuation range of the natural γ radiation was shown; the effect of various environmental factors was considered. Continuous studies on dose output determinations with the help of soil analysis and sensitive personnel dosimeters were summarized. (tr-auth)

14211 USE OF Sr–Ca RATIOS IN HAIR FOR MONITORING. Ebel, J. G.; Comar, C. L. (Cornell Univ., Ithaca, N. Y.). Health Phys., 16: 205-8(Feb. 1969).

Consideration has been given to the measurement of Sr/Ca ratios in hair as an indication of body burdens and exposures. Experiments were made with rats using both double tracer techniques and measurements of stable strontium and calcium. Two findings emphasize the difficulties that must be overcome if such measurements are to be useful: (a) The values of $OR_{hair/diet}$ and presumably of $OR_{hair/bone}$ were markedly affected by washing of the hair, and (b) discrepant results were obtained in comparisons of double tracer values and those from stable Sr and Ca analysis. The latter observation has also been reported by other laboratories and is as yet unexplained. (auth)(UK)

14212 THE MEASUREMENT OF ^{239}Pu IN VIVO. Ramsden, D. (United Kingdom Atomic Energy Establishment, Winfrith, Eng.). Health Phys., 16: 145-53(Feb. 1969).

The measurement of insoluble ^{239}Pu in the human lung by external counting is used routinely at A.E.E., Winfrith. The choice of detectors and problems of calibration are reviewed, and a brief description of the system is given. The limits of detection for plutonium in the lung depend critically upon the body build of the contaminated subject. The limit of detection of the routine system is of the order of 0.005 μCi ^{239}Pu. (auth)(UK)

14213 RELATIONSHIP BETWEEN THE ^{90}Sr/Ca RATIO IN THE DIET AND URINE OF A POPULATION. Czosnowska, W.; Pietrzak-Flis, Z.; Grabowski, D. (Central Lab. for Radiological Protection, Warsaw). Health Phys., 16: 155-8(Feb. 1969).

^{90}Sr/Ca ratios were determined in diet and urine samples taken from 40 teenagers during the period February 1965–May 1966. The mean value of the $OR_{urine/food}$ for the period was 1.03 ± 0.03. The small standard error of the mean seems to indicate that by pooling urine from a large number of persons, large individual variation can be eliminated to a satisfactory degree. (auth)(UK)

14214 THE RADIOLOGICAL HAZARDS OF ^{95}Zr AND ^{95}Nb. Fletcher, C. R. (Univ. of Birmingham, Eng.). Health Phys., 16: 209-20(Feb. 1969).

A survey of the metabolism of ^{95}Zr and ^{95}Nb by the rat was made, and the results obtained used to reassess the radiological hazards of these isotopes. The main conclusions are: (1) The gastrointestinal absorption of both elements may be a factor of twenty times greater than the figure of 10^{-4} used by the International Commission on Radiological Protection. (2) Maximum permissible levels for both isotopes in insoluble forms, or dissolved in water, remain unaltered, being set by irradiation of the gastrointestinal tract by its contents. (3) Maximum permissible levels for soluble forms of both isotopes in air are not significantly changed, providing no account is taken of non-uniform distribu-

tions within organs, or of hazards to a foetus. (4) The unsuspected foetus could easily receive a dose greater than 1 rem in the first 2 months of pregnancy, and it is calculated that the maximum permissible levels for soluble isotopes in air need to be 3.3×10^{-8} μCi of ^{95}Zr/cc of air, and 8.5×10^{-8} μCi of ^{95}Nb/cc of air, to prevent this. (5) During the last 7 months of pregnancy the maximum permissible levels for soluble isotopes in air need to be 4.9×10^{-9} μCi of ^{95}Zr/cc of air, and 10^{-8} μCi of ^{95}Nb/cc of air, in order that the integrated dose to the foetus in this period shall not exceed 1 rem. (auth)(UK)

14215 RESPIRATORY PROTECTION FOR URANIUM MINERS. Martz, Dowell Edward. Fort Collins, Colo., Colorado State Univ., 1968. 209p.

Thesis.

A method of analyzing filter samples by alpha spectroscopy was developed for accurately determining the airborne concentrations of RaA, RaB, and RaC in atmospheres contaminated with radon. The method was used to determine the concentration of radon daughter products in a uranium mine atmosphere and to evaluate respiratory protective devices worn by miners. Measurements of the radon daughter activity deposited in the respiratory tract of persons exposed to a representative mine atmosphere indicated average percent depositions of 50.7, 43.9, and 41.4% for the RaA, RaB, and RaC components. The fraction of the activity deposited depended on the properties of the aerosol inhaled and on the breathing pattern of the subject. Increased deposition was observed for large tidal volumes and low breathing rates. Several commercial and experimental respirator filters were tested for their ability to remove the radon daughter activity encountered in a mine atmosphere. High removal efficiencies were exhibited by densely packed fiber filters and by resin-impregnated wool filters. An in vivo counting system capable of detecting the RaC activity present in the respiratory tract of working miners was used to estimate the protection afforded by respirators under mining conditions. Protection factors of 5 to 10 were achieved by several commercial respirators. (Diss. Abstr.)

14216 DETERMINATION OF DOSE INTENSITY OF AN X-RAY BEAM AND DETECTION OF TOTAL REFLECTION IN A LEAD GLASS CAPILLARY. Buchholtz, Christiane; Freier, Guenther v.; Hagemann, Gerd (Philipps-Univ., Marburg, Ger.). Strahlentherapie, 136: 569-73(Nov. 1968). (In German).

The mean intensity of an X-ray beam of a lead glass capillary (cross section of about 10^{-6} cm^2), could neither be measured with the usual dosimeters nor by thin-walled ionization chambers, because of their low sensitivity. The use of a Geiger-counter-tube required an extensive calibration procedure for the X-ray energies to be measured. The procedure was outlined for a commercial type of Geiger-counter. The measured intensity at the exit of the capillary was of the order of magnitude of 18000 R/min. This was due to the total-reflection of the X rays within the capillary. (auth)

Medicine

Refer also to abstracts 13975, 14018, 14104, 14129, 14163, 14203, 14246, and 14282.

14217 (ORO-2401-15) INTERVAL DETERMINATION AND RADIOISOTOPE SCANNING. Brill, A. B.; Nash, R. T. (Vanderbilt Univ., Nashville, Tenn.). [1968]. Contract AT(40-1)-2401. 8p. (CONF-680641-1). Dep. CFSTI.

From 15th Annual Meeting of the Society of Nuclear Medicine, St. Louis, Mo.

A means of evaluating contouring procedures for radioisotope scans is presented and applications in an actual situation are described. This technique included the three essential influences of resolution, observational statistical uncertainty, and average emission distribution. It was concluded that the considered application of this technique will permit the construction of the most effective contour maps. It will further permit one to select from among various combinations of collimators, radio pharmaceuticals and scan rates best combinations on the basis of the criterion function, if the data are to be presented in the form of a contour map. (auth) (TSS)

14218 (ORO-2401-22) NEW APPROACH TO SCAN SYSTEM EVALUATION. Brill, A. B.; Williams, H.; Cook, E.; Johnston, R. E.; Nash, R. (Vanderbilt Univ., Nashville, Tenn. School of Medicine). [nd]. 9p. (CONF-681033-1). Dep. CFSTI.

From South Eastern Chapter Society of Nuclear Medicine Meeting, Atlanta, Ga.

The performance of a system for collecting, computer analyzing, and video tape displaying of data from radioisotope scans and applications of statistical decision theory in radioisotope scanning are discussed. The use of three-dimensional phantoms for the ^{99}Tc scanning of a normal brain with superimposed lesions is described to illustrate the procedure. (C.H.)

14219 (ORO-2401-27) PROGRESS REPORT [ON RADIOISOTOPE STUDIES AND CLINICAL APPLICATIONS, 1968]. (Vanderbilt Univ., Nashville, Tenn.). Oct. 1968. Contract AT(40-1)-2401. 92p. Dep. CFSTI.

Separate abstracts were prepared on two sections of this report. A list is included of publications during the period covered. (C.H.)

For abstracts of individual sections see: 14220 and 14221.

14220 (ORO-2401-27, pp 3-51) METHODOLOGY. (Vanderbilt Univ., Nashville, Tenn.).

The performance of a whole-body counting system for use in radioisotope scanning was evaluated. Computer programs for the IBM 7072 were written for computer analysis of counting data. Focusing and slit collimators were designed for visualization of high-energy γ-emitting radionuclides such as ^{85}Sr and ^{68}Ga using the whole-body scanner. A calibration curve was constructed for converting ^{40}K cpm from a patient into total grams of potassium. Data from 22 patients covering a wide range of age and weights are presented. Equations were developed for computer correction of dead time resulting from the conversion of analogue input signals from a multicrystal whole-body counter to a digital system for storage. Computer programs for the IBM 7072 for the analysis of radioisotope scan data are presented and discussed. Applications of statistical decision theory to clinical diagnosis based on results of radioisotope scans are discussed. A three-dimensional phantom produced by a mathematical superposition of lesions onto normal organ scans was developed for use in the development of radioisotope scan systems using computer analysis of scan data and videotape display. The development of an eight-crystal scanner assembly mounted in a circular array to allow focusing at a single common point to provide three dimensional information on radioisotope distribution in patients and the development of a Ge(Li) semiconductor detector for use in counting the activity induced by neutron activation of biological materials are described. (C.H.)

14221 (ORO-2401-27, pp 52-87) APPLICATIONS. (Vanderbilt Univ., Nashville, Tenn.).

The radiation doses to the fetus when ^{59}Fe or ^{131}I was used for tracer studies in pregnant females were calculated. Data are included on the content of ^{59}Fe and ^{131}I in various tissues of fetuses of various ages following adminstration of tracer doses to the mother. The radiation doses to the central nervous system of patients during brain scanning using ^{131}I-serum albumin and during the treatment of hydrocephalus using intraventricularly instilled ^{198}Au-colloids were calculated. The isotopic equilibration of ingested ^{42}K in the human body as a function of time was measured using a whole-body counter. Data from whole-body scans, using ^{42}K, ^{24}Na, ^{82}Br, and $^{3}H_2O$ as tracers, were used for body composition studies in normal and obese patients. The relationship between ^{42}K metabolism and several disease conditions was investigated. Methodology for processing and neutron activation of stable tracers in biological samples was studied. A procedure is described for neutron activation of Fe in blood samples and the use of a Ge(Li) semiconductor detector for counting γ activity from ^{58}Fe in the samples. (C.H.)

14222 (UCRL-Trans-1371) RESULTS OF THE EXAMINATION OF THE BOMB VICTIMS AT THE HUMAN DOCK. Kuramoto, Kyoshi; Fujinaga, Yutaka; Fujimoto, Yukio; Ishida, Sadamu. Translated for Univ. of California Lawrence Radiation Lab., Berkeley, from Nagasaki Igakkai Zasshi, Suppl., 38: 70-80 (1963). 80p. Dep. CFSTI.

Results of clinical studies related to physiological aging were compared for normal individuals of the same age and sex and a group of individuals exposed to radiation during the explosion of the atomic bomb at Hiroshima. The latter group included 73 individuals less than 2 km away from the explosion and 58 individuals who entered the city within five days after the explosion. About 87% of the individuals examined were over 40 yrs of age. Findings on blood pressure, electrocardiograms, examinations for ophthalmic arteriosclerosis, liver function, kidney function, and blood studies, including cholesterol content, glucose tolerance tests, and complete blood counts were compared. Survivors of the atomic bombing had significantly more frequent disturbances in blood pressure (high and low), more frequent disturbances in electrocardiograms, more frequent disturbances in kidney functions, and a higher incidence of ophthalmic arteriosclerosis than were found in the non-bombing group. No differences in liver function, blood chemistry, or hematological data were found between the two groups. (26 references.) (C.H.)

14223 EFFECTS OF ENDOLYMPHATIC ^{131}I-THERAPY ON PROTEIN AND CELLULAR CONSTITUENTS OF HUMAN BLOOD.

Klemm, D.; Pfannenstiel, P.; Weissleder, H.; Hoffmann, G. (Univ., Freiburg i. B.). Fortschr. Geb. Roentgenstr. Nuklearmed., 109: 587-93(Nov. 1968). (In German).

Changes in serum protein fractions and in the cellular components of peripheral blood were observed in 12 patients with malignant disease, or tumor metastases, in the inguinal or retroperitoneal lymph nodes, following endolymphatic ^{131}I therapy. Immediately following treatment, there was tissue necrosis leading to an increase in the acute phase proteins: α_1-glycoprotein, α_1-antitrypsin, α_2-macroglobulin, and haptoglobin, as well as of γ_A-globulin and an increase in peripheral granulocytes. There was transient increase in β_{1C}-β_{1A}-globulins. Due to the selective radiation of lymph nodes, and because of their radiosensitivity, there was a slight and transient reduction in the absolute lymphocyte count. (auth)

14224 CORONARY HEART DISEASE IN HIROSHIMA, JAPAN: A REPORT OF A SIX-YEAR PERIOD OF SURVEILLANCE, 1958–1964. Johnson, Kenneth G.; Yano, Katsuhiko; Kato, Hiroo (Atomic Bomb Casualty Commission, Hiroshima). Amer. J. Public Health, 58: 1355-67(Aug. 1968).

Results of a continuing epidemiologic study of coronary heart disease (CHD) in Hiroshima, Japan are reported. At the Atomic Bomb Casualty Commission in Hiroshima and Nagasaki a sample of 20,000 atom-bomb survivors and other persons has been under intensive clinical and mortality surveillance since 1958. This sample afforded an opportunity for observing the natural history of disease in the Japanese and its modification by ionizing radiation. Morbidity, mortality, and factors associated with differentials in the risk of CHD are the main subjects reported. CHD is a disease of low morbidity and mortality in Japan. Antecedent hypertension, especially elevated levels of systolic pressure and left ventricular hypertrophy as seen by ECG, was significantly associated with the development of CHD in both sexes. Serum hypercholesterolemia, at a level 220 mg% or more, and proteinuria are associated with an increased risk for men; so is cardiomegaly demonstrated roentgenographically in women. No association was found between an individual's habits and environmental factors and the occurrence of CHD. In particular, exposure to atom bomb radiation was examined in relation to the incidence and prevalence of CHD; no relation was found. (BBB)

14225 USE OF BARRIER CREAM FOR WORK WITH RADIOACTIVE SUBSTANCES. Tarasenko, N. Y.; Hodyreva, M. A. Gig. Tr. Prof. Zabol., 12: No. 2, 29-33(Feb. 1968). (In Russian).

Experiments with barrier cream aimed at providing additional protection for the hands when handling radioactive substances are reported. One criterion for judging the efficacy of barrier creams for this purpose is the extent to which the skin can be decontaminated. For handling dry radioactive substances involving only moderate contamination, barrier cream with a casein basis proved efficacious. For work with larger amounts of radioactive substances or repairs involving the risk of greater contamination, the combination of silicon barrier cream and rubber gloves provided the most effective protection (decontamination was 5–8 times better than with rubber gloves alone). (Occup. Safety and Health Abstr.)

14226 SENSITIZATION OF ANOXIC RECOMBINATION-DEFICIENT MUTANTS OF ESCHERICHIA COLI K12 TO X-RAYS BY TRIACETONEAMINE N–OXYL. Emmerson, Peter T. (Yale Univ., New Haven). Radiat. Res., 36: 410-17(Dec. 1968).

The radiosensitizing effect of triacetoneamine N-oxyl (TAN) on anoxic suspensions of two x-ray-sensitive mutants of E. coli K12 was investigated. With one mutant, AB2463 recA13, TAN increased the sensitivity (based on the dose required to give 1% surviving fraction) of anoxic cells by a factor of 3.9, while oxygen increased the sensitivity by a factor of only 1.9. On the other hand, on the same basis, TAN was only about one-half as effective as oxygen in sensitizing the mutant AB3058 rec-22. The results are interpreted in terms of the relative ability of the cells to recover from radiation damage produced in the presence of TAN and in the presence of oxygen. (auth)

14227 PROTECTIVE EFFECT OF CHLOROQUINE ON THE SURVIVAL OF MICE FOLLOWING WHOLE-BODY X IRRADIATION. Bielicky, T.; Zak, M. (Charles Univ., Prague). Cas. Lek. Cesk., 106: 1001-3(Sept. 1967). (In Czech).

In relation to the therapeutic effect of chloroquine in some photoinduced dermatoses and its protective effect in x-ray damaged skin, the effect of this drug on the survival of mice following whole body x irradiation with a dose of 600 R was studied. It was established that following administration of 6.3 μg/Kg resochin 1 hr before exposure, 20% of the exposed mice died whereas in the control group mortality reached 70%. Larger, as well as smaller, doses given before and all doses given half an hour after irradiation were less efficient, and lethality was even higher than in the control group. The effect of antimalaria drugs can be explained by their stimulative action on the pentose phosphate cycle, in promoting a faster synthesis of precursors indispensable for regenerative processes. Other mechanisms, as for instance the binding of chloroquine to nucleic acids, cannot be excluded. (BBB)

14228 CHEMICAL RADIOPROTECTION OF HEMOPOIETIC COLONY-FORMING CELLS: COMPARATIVE EFFECT OF AET, ANOXIA, AND URETHAN. Cole, Leonard J.; Davis, William E. Jr. (Naval Radiological Defense Lab., San Francisco). Radiat. Res., 36: 555-62(Dec. 1968).

The bone marrow colony-forming unit (CFU) technique of Till and McCulloch was employed to test the radioprotective effect of AET, anoxia, urethan on marrow cells irradiated in vivo. For AET and anoxia, a dose-reduction factor of 1.9 to 2.1 was found. Since the marrow cells were assayed for CFU content immediately after irradiation of the donor, the observed effect can be interpreted as a true radiation dose reduction. By contrast, urethan injection did not increase the survival of marrow CFU assayed immediately after whole-body x-irradiation. However, both urethan and AET afforded radioprotection of endogenous CFU content of spleen and bone marrow, but not of endogenous spleen colony count. It is concluded that the mechanism of radioprotection by urethan is fundamentally different from that of AET or anoxia. (auth)

14229 BETA IRRADIATION OF PTERYGIA. COMPARISON OF DIFFERENT AREAS TREATED. Cameron, Malcolm E. Brit. J. Ophthalmol., 52: 562-3(July 1968).

A comparison was made between the results obtained with a large (16-mm dia) circular applicator and a small kidney-shaped (9 × 5 mm) applicator in the treatment of primary and recurrent pterygium by excision and β irradiation with a surface dose of 2200 R. The pterygium was removed and a surface dose of 2200 R in one application was given immediately. Results obtained with this method were 84% cosmetically satisfactory. Without β-irradiation only 31% were cosmetically satisfactory. Statistical analysis indicated no difference in efficacy between the two applicators. With the 16-mm applicator more than four times the surface area is irradiated as compared with the 9 × 5 mm applicator, and irradiation time by surface application is reduced so that the smaller applicator reduces the irradiation dose exposure. (BBB)

14230 CLINICAL OBSERVATIONS AND TREATMENT IN CASE OF ACCIDENTAL TOTAL IRRADIATION. Jammet, H. P.; Gongora, R.; Le Go, R.; Marble, G.; Faes, M. pp 1249-91 of Radiation Protection. Part 2. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968. (In French).

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.2)).

The clinical observation and treatment of a technician accidentally exposed at the Venus reactor are reported. The irradiation was characterized by its suddenness, its importance, and its heterogeneity. There resulted a general whole-body irradiation syndrome and a local overexposure of a lower leg. The general syndrome had an initial phase of significant shock with vomiting, polynucleosis, and metabolic degradation; a three-week latency period during which the gravity of the illness was shown by breakdown of the hematopoietic functions; a four-week crisis phase characterized by a hectic febrile state, a total medullary aplasia, and grave toxemic manifestations; a spectacular recovery phase of the hematopoietic functions; a prolonged convalescence phase. The hematological examinations concerning the erythrocytes, the reticulocytes, the neutrocytes, the lymphocytes, the thrombocytes, the thrombo-elastography and the medullograms, and the cytogenetic examinations of the chromosomes made possible a clinical evaluation of the resulting total dose. The local over-exposure syndrome of one leg evolved, after a 10-day latency period, as an extremely grave radiolesion with conjunctive cutaneous, vascular, nervous, and bone manifestations. The treatment for the general syndrome consisted of bacteriologically controlled total isolation, antihemmorrhage prevention, administration of adequate antibodies, dietetic support, and erythrocyte transfusions. The treatment of the local syndrome was followed with bacteriological isolation, vivifying ointments, and injection of padutine. Amputation eventually was necessary. (tr-auth)

14231 EFFECT OF DEOXYRIBONUCLEIC ACID ON THE SURVIVAL TIME AND THE HISTOCHEMICAL AND MORPHOLOGICAL CHANGES OF THE RAT LIVER AFTER IRRADIATION. Bankowski, Z.; Polowiec, Z.; Steplewski, Z.; Wilczok, T. (Centre de Recherche Pathologie Experimentale, Varsovie, Poland.

Institut d'Oncologie, Gliwice, Poland). Ann. Histochim., 12: 113-24(1967). (In French).

Male and female Wistar rats, aged 3.5 to 7 months were totally irradiated by a single dose of 900 R (5/min) of γ rays from ^{60}Co source. Calf thymus highly polymerized DNA was infected intraperitoneally in doses of 3 mg each, 24, 48, and 72 hours after irradiation. All irradiated animals not submitted to DNA died between the 5th and 18th day. The survival time of treated animals varies, according to the experiences, between 58 and 71%. By histochemical means, alkaline and acid phosphatases, DNA-A II, ATP-A, and lipids were demonstrated. We have also investigated the liver histologically. The histochemical and morphological patterns of DNA-treated rat liver until the 12th-day after irradiation are similar to control livers, whereas irradiated and non-treated rat liver shows extended necrosis and lipidic degeneration. Results seems to indicate an increase of the regenerating power of administered DNA. (auth)

14232 ON THE LACK OF CYSTAMINE PROTECTION AGAINST THE ACTION OF ELASTIC NUCLEAR COLLISIONS. Jung, H. pp 122-7 of Molekulare Struktur und Strahlenwirkung. Glubrecht, H. (ed.). Stuttgart, Georg Thieme Verlag, 1968. (In German).

From Annual Meeting of the Molecular Structure and Radiation Effects, Hanover, Ger. See CONF-660671.

In a large number of different types of biological systems, the sensitivity to ionizing radiation decreased when radioprotective substances were present during the irradiation. It was recently determined that elastic nuclear collisions destroy the enzymatic activity of ribonuclease with great efficiency. A study was made to determine whether a protective effect also occurs when the radiation energy was carried not by excitations and ionizations but by elastic nuclear collisions. If 0.7 μg of ribonuclease or 0.4 μg RNase and 0.3 μg of cystamine were irradiated with ionizing protons of 2 MeV, the radiation resistance of ribonuclease in the presence of cystamine was higher by a factor of 1.8 than of pure RNase. In contrast, using 1.4-keV protons, that lose their energy almost exclusively by elastic nuclear collisions, the radiosensitivity of RNase was not affected by the introduction of cystamine. These results suggest that cystamine can be protective only when the transfer of the radiation energy proceeds by electron processes. (tr-auth)

14233 ATTENUATION OF RADIO-INDUCED INJURIES IN MICE BY MEANS OF VI-ANTIGEN S. TYPHI AND COLIBACTERINE (ESCHERICHIA COLI M_{17}). Ivanitskaya, A. F. (Inst. of Biological Development, Moscow). Dokl. Akad. Nauk SSSR, 182: 701-4(1968). (In Russian).

Studies with 860 hybrid and control white mice weighing 18 to 20 g exposed to whole-body x irradiation showed that the average survival of control mice after exposure to 700 R was 18.1 ± 3.3% while the survival of hybrids treated with Salmonella typhi antigen was 50.0 ± 4.2%. The survival of hybrid control mice after exposure to 600 R was 30.2 ± 6.3% and 62.8 ± 7.1% of S. typhi antigen-treated hybrid mice. The tests with the S. typhi antigen combined with Escherichia coli injected into control mice exposed to 700 R resulted in survival of 52.8 ± 4.8% of treated animals and 16.5 ± 4.2% in non-treated. With hybrid mice irradiated with 600 R the survival of treated mice was 73.0 ± 8.3% and non-treated 25.0 ± 8.2%. Results of the cytological analysis of activated reticular cells in spleen preparation are tabulated. (R.V.J.)

14234 CENTRAL COMPONENT IN THE MECHANISM OF ANTIRADIATION ACTION PRODUCED BY MEXAMINE AND BETA MERCAPTOETHYLAMINE. Strelkov, R. B.; Parasochko, L. A. (Inst. of Experimental Pathology and Therapeutics, Moscow). Farmakol. Toksikol., 30: 615-16(1967). (In Russian).

Suboccipital introduction of mexamine in a dose of 2.5 mg/kg, which becomes inactive with subcutaneous and intraperitoneal administration elicits a distinct protective effect. A subliminal protective dose (25 mg/kg) of β-mercapto-ethylamine introduced by the suboccipital route fails to produce any protective action. (ATD)

14235 ROLE OF LASERS IN BIOLOGY AND MEDICINE. Smart, D.; Hornby, P. (International Research and Development Co., Newcastle-upon-Tyne, Eng.). Phys. Bull. (London), 20: 5-9(Jan. 1969).

A description is given of the applications of lasers in biomedical research and clinical medicine. The novel contributions of lasers in these fields are detailed and, where appropriate, contrasted with other techniques. An indication is also given of the possible future uses of lasers. Uses include for studying the structure and function of tissues in health and disease, and the modification or destruction of living tissue for the purposes of surgery and therapy. The biological effects of laser radiation are briefly outlined; these include a thermal effect, with a possible secondary effect due to generation of ultrasonic waves within the irradiated medium, an electric field effect, and a pressure wave effect. The employment of such effects is described. (UK)

14236 FACTORS MODIFYING THE EFFECT OF SINGLE DOSE OF X-RAYS ON REGRESSION OF THE TRANSPLANTED RIB5 TUMOUR. I. EFFECT OF BREATHING 5 PERCENT CARBON DIOXIDE AND 95 PERCENT OXYGEN AT ATMOSPHERIC PRESSURE ON TUMOUR REGRESSION. Watanabe, Noritoshi; Thomlinson, R. H. (Experimental Radiopathological Research Unit, England). Nippon Igaku Hoshasen Gakkai Zasshi, 27: 1558-71(Mar. 1968). (In Japanese).

The tumors were transplanted to form spherical masses beneath the skin of the flank and were irradiated with 250 kv x rays when they were between 8 and 10 mm in diameter. One hundred and thirty five tumors were irradiated. The mean diameter of the tumors at the time of irradiation was 8.8 ± 0.23 mm. The animals were irradiated while breathing the following gases: air, pure oxygen at 3 atms, 5% carbon dioxide and 95% oxygen at atmospheric pressure, and also when the tumors were made anoxic by clamping the blood supply. The results of irradiation were determined from daily measurement of the size of tumors and from the mean time taken by each group of tumors to grow and reach a diameter of 20 mm. The radiosensitivity of tumors was divided into an aerobic (radiosensitive) fraction and an anaerobic (radioresistant) fraction. The aerobic fraction increased as oxygen concentration increased and as oxygen pressure increased. However, there was no significant difference in tumor radiosensitivity between gas mixture at 1 atms and 100% pure oxygen at 3 atms; both groups were irradiated at a single dose of 1.500 rads. Therefore the gas mixture inhalation at atmospheric pressure was the technique chosen for therapeutic use among those investigated. (TSS) (NSA of Japan)

14237 MEASUREMENT AND CLASSIFICATION OF THE RENOSCINTIGRAM USING ^{203}Hg-NEOHYDRIN. Isao, Kuniyoshi (Kanazawa Univ., Japan). Kanazawa Irigaku Sosho, 80: 32-69 (July 1967). (In Japanese).

A phantom experiment using ^{203}Hg-neohydrin was performed. As the result, the scintigram of 20% off from normal is good because of the quality of the picture, clearness of the constitution and constancy of the value. The length and width of the renoscintigram were measured in the cases of hypertension, renal stone and ureteral stone and in normal cases. In the cases of renal tumor, the length and width of the scintigram of the normal-side kidneys were measured. The length of the renoscintigram was determined by measuring the maximum distance from the cephlad to the caudad margin. The width was determined by measuring the minimum distance, which passes the mid-point of the length, from the lateral to the medial margin. The size of the renoscintigram was determined in normal cases, in hypertensive cases, in cases of renal stone and ureteral stone, and in patients with normal-side kidneys and renal tumor. The renoscintigrams were classified empirically into 12 types. Incidence of diseases showing each type is described and in a certain probability the disease or clinical condition was diagnosed empirically in accordance with the renoscintigram types. In the cases of renal tumor, the types of the amputation of upper part and lower part of the renoscintigram were specific. In the cases of renal tuberculosis, the partially mottled type was specific. In the hypertensive cases, the shrunk type was specific. The renoscintigrams of the solitary kidney cyst showed the oval-like defective type, but were difficult to differentiate from cases of renal tumor. The contours were almost invisible on the renoscintigrams in cases of polycystic kidney, but when the oval-like defective types were observed bilaterally, the diagnosis was easy. (TSS) (NSA of Japan)

14238 DIAGNOSIS OF THYROID DISORDERS USING RADIOACTIVE IODINE. Greig, W. R.; Boyle, I. T.; Boyle, J. A. Medical Monograph No. 5. Amersham, Eng., Radiochemical Centre (UKAEA), 1967. 36p.

The techniques and their limitations for measuring thyroid activity with radioactive iodine are outlined. Various methods of evaluating thyroid function and pathology are described, and a brief account given of diagnostic criteria for common thyroid disorders. Among matters discussed are: thyroid development and physiology, radioactive isotopes of iodine employed (^{125}I, ^{131}I, ^{132}I), thyroid uptake tests, urine excretion tests, protein bound radioiodine tests, thyroid suppression tests, TSH stimulation test, perchlorate discharge test, thyroid clearance of plasma radioiodine, absolute iodine uptake by thyroid, thyroid scanning, other tests based on plasma protein bound radioiodine (butanol extractable radioiodine, uptake of radioiodinated triiodothyronine by red cells), application and integration of tests in clinical practice (diagnosis of hyperthyroidism and hypothyroidism, diagnosis of cretinism, determination of type of non-toxic goiter). (UK)

14239 WHOLE BODY LINEAR SCANNING WITH ^{59}Fe. Miura, Takeo (Nagoya Univ., Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 27: 1578-86(Mar. 1968). (In Japanese).

To demonstrate the erythropoietic tissues, two-directional, whole-body scanning, head to foot and right to left (at the height of the liver and spleen), was performed at 6, 24 hours, and 10 days after the intravenous injection of ^{59}Fe. A 10 cm thick slit-collimator to suit the strong gamma-ray of ^{59}Fe was used. If normal, the liver showed slightly higher activity than the spleen and a peak over the spinal bone marrow was marked by transverse scanning at 6 and 24 hour periods. Two large peaks were observed over the chest and the pelvic bone in the longitudinal scanning at 6 and 24 hour periods. A peak was observed over the heart in the longitudinal scanning after 10 days. A peak seen at 6 and 24 hour periods at the middle in the transverse scanning disappeared after 10 days. In patients with iron deficiency anemia, a peak over the spleen was noted by transverse scanning at 6, 24 hour, and 10 day periods. This would imply intra- and extra-medullary hemolysis. In patients with polycythemia vera, a peak was marked over the head at 6 and 24 hour periods. This would mean the expansion of erythropoietic bone marrow. In patients with hemolytic anemia, peaks over the chest and pelvic bone were lower and showed deranged patterns of erythropoietic bone marrow distribution in the longitudinal scanning at 6 and 24 hour periods. A marked peak over the spleen due to hemolysis was observed in the transverse scanning after 10 days. A patient with myelofibrosis had a similar pattern to hemolytic anemia. A peak over the spleen was also observed in the transverse scanning at 6 and 24 hour periods due to extramedullary erythropoiesis. In patients with erythroid aplasia, a peak over the liver was marked and no other bone marrow peak was observed in the scanning at 6, 24 hour and 10 day periods. A patient with hemosiderosis showed such a high peak over the liver as observed in erythroid aplasia. However, erythropoietic bone marrow activity was observed in hemosiderosis, but not in erythroid aplasia. No sign of recovery of erythropoiesis was seen in the area that received therapeutic gamma-ray irradiation. As described above, this method is available for the differential diagnosis of various hematologic disorders, since the method is simple, quick and affords sufficient information without the pain of a bonemarrow puncture. (TSS) (NSA of Japan)

14240 DOUBLE ISOTOPE TECHNIQUE OF MEASURING HEPATIC FUNCTION UTILIZING ^{198}Au COLLOID AND ^{125}I-ROSE BENGAL. Kajita, Akiyoshi (Kobe Univ., Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 27: 550-9(Aug. 1967).

Simultaneous measurement of hepatic uptake rate constant of ^{198}Au colloid and peripheral disappearance rate of ^{125}I-Rose Bengal (double isotope technique) was made possible by means of a three channel γ-spectrometer system and a newly developed calibration chart after suitable corrections. According to this double isotope technique, the disturbance of the hepatic hemodynamics could be evaluated after separating into the decrease of effective liver blood flow and into the hepatobiliary dysfunction. When the results of the combined tests were plotted on same diagram, each hepatic disease shows the characteristic distribution, and these results not only provide the means to make the differential diagnosis, but also suggest the progress of various hepatic diseases. Basic problems concerning the simultaneous use of ^{198}Au colloid and ^{125}I-Rose Bengal and their clinical applications were also discussed. (NSA of Japan)

14241 AVOIDANCE OF THE POSSIBILITY OF ERROR BY COORDINATION OF SCINTIGRAMS WITH X-RAY PICTURES. Huehn, E. A. (Staedtische Krankenanstalte, Dortmund, Ger.). Fortschr. Geb. Roentgenstr. Nuklearmed., 109: 635-40(Nov. 1968). (In German).

After a discussion of the available methods of correlating scintigrams and radiographs, two procedures which are technically easy, which achieve a high degree of accuracy and are applicable in all instances are described. Errors of individual methods, owing to various types of radiation geometry, are shown in diagrams. In order to facilitate the practical application, the diagrams also indicate the margin of error to be expected, allowing proper correlations between scintigrams and radiographs to be made. (auth)

14242 BASIC STUDIES OF THE SHORT HALF LIFE NUCLIDE ^{18}F FOR THE DIAGNOSIS OF BONE DISEASE. Sato, Fumio (Kanazawa Univ., Japan). Kanazawa Irigaku Sosho, 78: 57-7(Jan. 1967). (In Japanese).

For the purpose of earlier diagnosis of bone diseases not demonstrated on x-ray film, the possibility of using ^{18}F which has a strong affinity to bone tissue and has a short half life was studied. The production of ^{18}F in a uranium pile and cyclotron was investigated and animal experiments performed. The following results were obtained. The production of ^{18}F in a uranium pile was carried out by bombardment of lithium carbonate, with thermal neutrons. Radioactivity obtained was about 100 μCi/5 g and pH 7.2 to 8.8. Bombardment of water with deuteron in a cyclotron gave about 50 μCi/3ml H_2O of ^{18}F. The pH was almost neutral. Radiochemical purity both immediately after bombardment and 30 minutes after chemical processing showed excellent results indicating pure ^{18}F, half life 1.8 hr, energy 0.51 MeV, 1.02 MeV. Half value layer for ^{18}F radiation was 4.5 mm thickness of Pb. ^{18}F was selectively incorporated into bone mineral but not into other soft tissue. Normal bone tissue took up ^{18}F very rapidly in the initial phase and thereafter reached saturation. Either traumatic injured bone or irradiated bone revealed uptake of ^{18}F 6 to 8 times that of the control. Injured parts showed 30 to 40% higher uptake than normal parts of injured bone. This difference continued more than 30 minutes. These results provide new fundamental information for clinical application of ^{18}F to bone diseases. (TSS) (NSA of Japan)

14243 STUDIES ON DIAGNOSTIC APPLICATION OF RADIOISOTOPES IN NEUROSURGERY. PART 2. RADIOISOTOPIC METHOD FOR EVALUATING THE PATENCY OF VENTRICULOATRIOSTOMY. Kodama, Motomu (Hiroshima Univ.). Hiroshima Daigaku Igaku Zasshi, 15: 495-512(June 1967). (In Japanese).

In 63 cases of hydrocephalus caused by several etiological factors, 88 Ventriculoatriostomies were performed. The operation can be applied even for cases of poor risk; there is no operative death, no loss of body fluids, and the decompression effect lasts a long time. However, the obstruction of Pudenz–Heyer's tube occurs at a high frequency, requiring reoperation. Two cases of sepsis were experienced as a complication. In order to test the patency of the cerebrospinal canal, RISA or ^{131}I-PVP was injected into a lateral ventricle and radioisotope (R.I.) clearance was measured. In cases of posterior cranial fossa tumors and arachnitis with internal hydrocephalus, the 24 hr-value of R.I.-clearance was above 30%, in supratentorial tumors without internal hydrocephalus 5 to 20%, and after ventriculoatriostomy, it was below 5%. The measurement of R.I. transfer into lumbar punctate showed nearly the same result as in the PSP test. Injecting 20 to 50 μC of R.I. and measuring the radioactivity in peripheral blood after 1 and 4 hours are clinically useful. If there is no obstruction of Pudenz–Heyer's tube, its 4-hr-value increases rapidly; then, the radioactivity is also observed in the urine. In order to test the patency of Pudenz–Heyer's tube after ventriculoatriostomy by external counting, R.I. was injected into a lateral ventricle; a scintillation counter was set at the heart region. The method is somewhat uncertain, but clinically useful, because, when the tube is patent, a high count is shown after 4 hours. (TSS) (NSA of Japan)

Radiation Effects on Animals

Refer also to abstract 14143.

14244 THE EFFECT OF DOSE RATE DURING X-IRRADIATION OF AMEBA PROTEUS. Paribok, V. P.; Kal'nii, V. S.; Ikonnikova, T. B. (Inst. of Cytology, Leningrad). Tsitologiya, 10: 1479-84(Nov. 1968). (In Russian).

Culture mineral medium irradiated by 60 krad, with dose rate being 30 krad/min., has no toxic action on non-irradiated Ameba proteus but reveals only an insignificant effect on irradiated amebas applied during 24 hours. Amebas are insensitive to the treatment with 5 and 50 mcg/ml of H_2O_2 during 2 hours. The effect of dose rate by x-irradiation of A. proteus cannot be explained by a radiochemical transformation of the medium. The dependence of the effect of dose rate on the temperature during irradiation of amebas is in conformity with the hypothesis about the role of reparation in this effect. (auth)

Invertebrates

14245 EFFECTS OF X-RAY RADIATION ON SURVIVAL OF THE CEREAL LEAF BEETLE OULEMA MELANOPUS (L). Carey, Walter Emmitt. Columbus, Ohio, Ohio State Univ., 1968. 63p.

Thesis.

Basic survival parameters of three life stages of the cereal leaf beetle were studied after exposure to x rays. This information was acquired as a necessary prerequisite for projected physiological studies and as a foundation from which economic entomologists could consider radiation as a potential control method. All the irradiations were performed with a constant potential x-ray machine operating at from 150 kV to 250 kV. The emitted radiation had half value layers ranging from 7.9 mm of aluminum for 150 kV to 10.4 mm of aluminum for 250 kV. X-ray

machine calibrations were conducted with both ionization chambers and thermoluminescent dosimeters. Adult irradiations were carried out on both field-collected and laboratory-reared insects with tube potentials from 150 kV to 250 kV and with exposure rates from 100 R/min to 370 R/min. For field collected individuals, mortality ranged from 20% at 6.5 days post-irradiation to 80% at 12.5 days post-irradiation for an 8000 R exposure and from 20% at 11 days post-irradiation to 80% at 32 days post-irradiation for a 1000 R exposure. These and intermediate values of both exposure and mortality were included in graphical form. The general conclusions that were drawn from the adult studies were: no statistically significant difference in sensitivity existed between males and females; no difference existed between effects of 150 kV and 250 kV accelerating potentials; no exposure rate effect existed, for acute exposures, within the range of 100 R/min to 370 R/min; field-collected individuals were more sensitive than laboratory reared individuals, and the cereal leaf beetle was one of the most radiosensitive species studied to date. Pupal irradiations were conducted with a 250 kV tube potential and an exposure rate of 270 R/min. No statistically significant effect on adult emergence was observed for exposures of up to 6000 R. However, at the time of hibernation, a marked effect was noted on adults that had emerged from irradiated pupae. A 1000 R exposure resulted in 80% survival, with respect to controls; and survival percentages of 36%, 9%, and 1% resulted from exposures of 2000 R, 4000 R, and 6000 R, respectively. The dose-response curve had the shape of either a multitarget or multihit curve, with an extrapolation number of two. Egg irradiations were conducted with a 200 kV tube potential and an exposure rate of 10 R/min. With these irradiation conditions, the results could be used as a standard of comparison for RBE studies. Egg age at the time of irradiation varied from three to 27 hours. Egg hatch was reduced to 77% of that of the controls by a 175 R exposure, and to 3% of the controls by a 500 R exposure. Other values were given in both tabular and graphical form. The dose-response curve had the shape of a multitarget curve with an extrapolation number of six. On the basis of the egg irradiation data, three alternatives to conventional target theory were proposed. (auth) (Disser. Abstr.)

Vertebrates

Refer also to abstracts 14117, 14118, 14127, 14128, 14228, 14231, 14233–14236,

14246 (UR-49-976) SOVIET VIEWS ON THE BIOLOGIC EFFECTS OF MICROWAVES. Michaelson, Sol M. (Rochester Univ., N. Y. Dept. of Radiation Biology and Biophysics). July 17, 1968. Contract W-7401-eng-49. 8p. (CONF-681110-1). Dep. CFSTI.

From Engineering in Medicine and Biology Conference, Houston, Tex.

Although some Soviet investigators describe the thermal nature of microwaves, the majority stress non-thermal or specific microwave effects at the molecular and cellular level. Studies performed in the United States generally reflect the physiologic response of the organism to the thermal burden imposed by microwaves. Microwaves affect a variety of organisms from protozoa to mammals. Effects may occur at low as well as high intensities of irradiation and are characterized by responses that involve reaction of the entire organism to changes at the molecular level. With the progressive improvement and intensified power of microwave generating units for military and civilian use, interest in the biologic effects and potential hazard has increased. Experiments on animals and surveys on humans have been performed in the U.S.A. and the USSR to investigate some of these problems. The importance of the difference between the Soviet and Western views is readily apparent when it is realized that practical consideration of maximum permissible exposure is based on the acceptance or rejection of non-thermal effects of microwaves as being of biologic significance. The extensive amount of work on the biologic effects of microwave exposure that has been done in the Soviet Union is a result of involvement by Institutes that have assumed the leadership in this area and have developed a systematic approach to these investigations. Soviet investigators suggest that chronic irradiation of animals with low intensity microwaves (< 15 mW/cm^2) may induce functional changes in the nervous and cardiovascular systems without a rise in tissue temperature. The changes are observed with chronic and single exposures. Higher field intensities produce a thermal effect that can damage brain and testes, cause internal hemorrhage, burns, necrosis of tissues, and produce lenticular opacities. Microwave irradiation results in a more intense flow of afferent impulses and more intense stimulation of hypothalmic-hypophysial activity than does thermal irradiation at equivalent energy levels. The apparent adaptation to repeated microwave exposures is referable to stimulation of skin receptors. As interpreted by Presman, when man is exposed to low frequency microwaves (600-1000 MH$_z$) the effect on the subcortical structures predominates over the effect on skin receptors. At higher frequencies only the skin receptors are affected. Intensities below 10 mW/cm^2 may be considered non-thermal for pulsed and CW microwaves of biologically effective frequencies in either whole-body or local irradiation. With intensities of 10 mW/cm^2 or less, conversion of microwave to thermal energy does not exceed the heat loss from 1 cm^2 of body surface under normal environmental conditions. The Soviets have frequently reported loss of memory, headaches, insomnia, etc., all of which are related to cortical stimulation. Functional damage to the cardiovascular system in persons that work in rf fields is reported. In discussing the Soviet views on the biologic effects of microwaves it should be emphasized that Soviet studies are oriented toward the Pavlovian concept of nervism. (auth) (TSS)

14247 (UR-49-1012) THE EFFECT OF 2800 MHz MICROWAVES ON THE EYE OF RABBITS AND DOGS. Michaelson, Sol M. (Rochester Univ., N. Y. Dept. of Radiation Biology and Biophysics). Oct. 25, 1968. Contract W-7401-eng-49. 28p. (CONF-681030-1). Dep. CFSTI.

From Symposium on Radiation Biology of the Ocular Lens, Rochester, Mich.

Rabbits were irradiated using a bench-model, Magnetron, continuous-wave microwave generator. Only the left eye was irradiated, the right serving as a control. The eyes were examined at frequent intervals after exposure for three to six month periods. Changes in opacity of the lens and conjunctival reactions after exposure to 220 to 240 mW/cm^2 and 160 to 170 mW/cm^2 for different lengths of time are described. Studies on protein and nucleic acid metabolism failed to reveal any significant differences between the experimental and control lenses. In studies on dogs an Air Force Radar Search Unit (AN/FPS-6) modified for biomedical investigations was used. The eyes were exposed at 350 or 700 mW/cm^2 for different lengths of time. Opacities and striations in the lens, conjunctivitis, dilatation of the pupil, and other changes in the eye are described. Results of studies on effects of radiation on the eye conducted by other workers are discussed. (H.L.W.)

14248 LEUKEMIA IN A RHESUS MONKEY (MACACA MULATTA) FOLLOWING EXPOSURE TO WHOLE-BODY PROTON IRRADIATION. Siegal, Alan M.; Casey, Harold W.; Bowman, Robert W.; Traynor, Joseph E. (School of Aerospace Medicine, Brooks AFB, Tex.). Blood, 32: 989-96(Dec. 1968).

The animal was one of a group of 123 primates exposed to 400 MeV proton irradiation at the University of Chicago cyclotron in March, 1965. Thirty-two months later the animal developed acute granulocytic anemia. A complete blood count revealed a total white cell count of 204,500 per mm^3. Electron photomicrographs of blast type leukemic cells are presented, and a table is presented to show hematology data over the postirradiation period. It is interesting that the reported cases of radioinduced leukemia in primates have been acute granulocytic, while all cases of spontaneous leukemia in monkeys have been chronic lymphatic. (H.L.W.)

14249 EFFECTS OF PROLONGED LOW LEVEL RADIATION ON THE CORONARY VESSELS OF THE DEVELOPING CHICK EMBRYO. Davis, J. E. Jr. (Madison Coll., Harrisonburg, Va.). Anat. Rec., 161: 247-52(June 1968).

Attempts were made to determine whether radiation produced by microcurie amounts of radioactive compounds produces any discernible effects on selected tissues and whether effects occur if the dose rate involves a relatively long period of time. Small doses of ^{32}P, ^{22}Na, ^{59}Fe, and ^{36}Cl in normally occurring compounds were injected directly into the vitelline vessels of developing chick embryos at Hamburger and Hamilton stage 24. The surviving embryos were sacrificed at stage 41. Hearts were removed and examined intact or sectioned for later examination. Coronary vessels were identified, classified according to size (large, dia = >80 μ; medium, dia = 40–80 μ; small, dia = <40 μ) and counted. There was a significant increase in the numbers of small and medium vessels which had developed in the presence of γ radiation emitted by ^{22}Na and ^{59}Fe compounds. The ^{32}P- and ^{36}Cl-containing compounds did not affect the numbers of vessels of any size. The resulting increased vascularity is shown to be a matter of a distinct increase in the number of blood vessels as opposed to a simple alteration of the normally occurring vessels. (BBB)

14250 SOME CHARACTERISTICS OF THE CRYPT CELL POPULATION KINETICS IN NORMAL AND IRRADIATED SMALL INTESTINE OF THE MOUSE. Kononenko, A. M. (Central Re-

search Inst. of Roentgenology and Radiology, Leningrad). Tsitologiya, 10: 1411-24(Nov. 1968). (In Russian).

The theoretical concepts of a steady-state lead to the conclusion that the main force responsible for the cell movement from crypts to the villi is a physical pressure developed by multiplying and growing cells. The kinetic equation of the crypt cell population is the result of this supposition. Detailed experimental investigation of the crypt cell population kinetics during three days after the total acute x-ray irradiation of the mice at the doses 700, 900 and 1200 rad is presented. The comparison of solutions obtained for the kinetic equation with the experimental results led us to the conclusion that the crypt cell population of the intestinal epithelium is an autostabilizing system. During the first 6 to 8 hours after irradiation at doses of 700 and 900 rad the cell leaving the crypts for the villi is of greater significance in the crypt depopulation than the interphase death of cells. Following 1200 rads, however, these effects become more equable. (auth) (TSS)

14251 DEYSTVIYE UL'TRAFIOLETOVOY RADIATSII NA KLETKU. (Effects of Ultraviolet Radiation on the Cell). Samoylova, Kira Aleksandrovna. Leningrad, Izdatel'stvo Nauka, 1967. 143p.

This book, written on a technical level, is intended for space-oriented and ground-oriented specialists in medicine, agriculture, and industrial microbiology. The vast amount of experimental material related to the effect of uv radiation on the cell is summarized. Special attention is given to peculiarities of the lethal, antimitotic, and stimulating effects of uv rays; to the factors determining the cell's sensitivity to uv radiation; to analysis of the uv radiation effect on cell structure and metabolism; and to the modern concepts of the molecular nature of the cytological effects of uv rays. Genetic effects of uv radiation and materials concerning photoreactivation are treated very briefly in this monograph, because of their extensive coverage in foreign and domestic literature. The problem of dark recuperation is discussed mainly as an aspect of the molecular mechanism of separation processes and their importance in the radiosensitivity of the cell. (ATD)(TSS)

14252 RADIATION DEATH ON CONTINUOUS X-RAY IRRADIATION IN MICE. PART 3. CHANGES OF ORGAN WEIGHT. Ikeda, Yoshiharu (Hiroshima Univ.). Hiroshima Daigaku Igaku Zasshi, 15: 431-67(June 1967). (In Japanese).

Male ddN-strain mice weighing 20 to 25 gm were subjected to continuous whole-body x irradiation at dose rates of 100 to 10,000 R/day. The moist and dry weights of their spleen, stomach, small and large intestines, pancreas, kidney, liver, lung, heart, testes, thyroid gland, and brain were measured successively. The same measurements were also made on non-irradiated, starved mice. The weight of the spleen decreased markedly from day 1 after irradiation began. It was supposed that the destruction of cell components caused by irradiation was the chief factor; also, the decrease in food intake after irradiation was considered. In weight decrease, the intestines followed the spleen with the decrease in food intake possibly related. The decrease was relatively gradual at 100 to 300 R/day and relatively rapid at 800 to 10,000 R/day. Between the two dose ranges there seemed to be a threshold where a rapid impediment of the digestive canals occurred. The pancreas and kidneys weight losses were very small and secondary metabolic disturbances appeared to be chief factors. Weight decrease of the liver was relatively large and similar to that of the intestines. The decrease in food intake was more involved here than in other organs. The reduction in supply and consumption of restored substances seemed to be other chief factors. Weight loss of the lungs, heart, thyroid gland, and brain was also scarce. The weight decrease of the testes was relatively large; it appeared that the destruction of cell components by irradiation was the chief factor and that the decrease in food intake was not involved. (TSS) (NSA of Japan)

14253 INFLUENCE OF SINGLE X-IRRADIATION WITH MASSIVE DOSES UNDER HYPOTHERMIA UPON THE HEMATOPOIETIC ORGANS. Takei, Hideo (Shinshu Univ., Japan). Shinshu Igaku Zasshi, 16: No. 1, 81-100(Feb. 1967). (In Japanese).

Male Wistar rats weighing 180 to 240 gm were x irradiated at single massive doses; rectal temperature was 20 to 25°C. Hemoglobin content, leukocyte count, erythrocyte count, serum iron content, blood picture, bone marrow picture, and histological changes in liver and spleen were studied. Results were compared with those from rats with normal temperature (NT) that were irradiated. Although serum iron decreased temporarily after irradiation, there was no marked difference between the hypothermia (HY) and NT irradiation in both whole-body and partial irradiation (right thigh only). The decrease of hemoglobin content was smaller under HY than under NT in whole-body irradiation. In partial irradiation, there was no difference between the two groups. The erythrocyte count reached a minimum at 3 days and about two weeks after irradiation under NT with whole-body irradiation; it recovered sooner under HY than under NT. Following partial irradiation, there was no difference between the two groups. The leukocyte count decreased in the 1st week after irradiation and thereafter increased in all groups; this disturbance was slighter under HY than under NT. There was no marked difference in blood picture between all groups. In the bone marrow picture, leukopoiesis was more active under HY than under NT, indicating that hypothermia prevented the lowering of leukopoiesis. Histologically, the damage to bone marrow was smaller under HY than under NT; following partial irradiation, recovery was sooner in the whole-body irradiated group. Histologically, necrosis of liver cells and inequality in the size of nuclei were seen after irradiation. Follicular atrophy was marked in the spleen 3 days after irradiation; regeneration started after 1 week. In both organs, the degree of injuries was smaller under HY than under NT in the whole-body and the partial irradiation groups. (TSS) (NSA of Japan)

14254 RADIATION EFFECT UPON THE SURVIVAL OF RATS IRRADIATED IN CONDITIONS OF ACUTE STARVATION. Dragic, Marko; Ninkov, Vukosava; Hajdukovic, Srdjan; Karanovic, Jovo (Boris Kidric Inst. of Nuclear Sciences, Belgrade). Strahlentherapie, 136: 617-20(Nov. 1968).

The effect of x radiation on rats previously deprived of food for 4 days has been studied in order to determine whether and to what extent the conditions of starvation change their radiosensitivity in terms of $LD_{50/30}$. Results have shown that radioresistance of fasted irradiated rats did not change if compared with that of normal irradiated animals. The value for $LD_{50/30}$ for fasted animals was 667 ± 13 R while for normally fed animals it was 647 ± 22 R. (auth)

14255 IONIZING RADIATION AND LIFE SHORTENING. Burch, P. R. J. Nucl. Safety, 10: 161-70(Mar.-Apr. 1969).

Evidence is reviewed concerning the life-shortening effects of ionizing radiation on experimental animals and on man. A qualitative distinction is drawn between acute radiation death following within 30 days of a large dose of radiation to the whole body, and delayed effects, which in man may be manifested some years or even decades after either acute or chronic exposures to radiation. Biological interpretations of both forms of mortality are presented. Quantitative predictions about the delayed outcome of irradiations are fraught with uncertainty. Nevertheless, an attempt is made to estimate the possible influence of maximum permissible levels of radiation on mortality rates. (auth)

14256 EFFECT OF IRRADIATION ON THE CHANGE OF CELL AREA OF LEUCOCYTE. Yoshida, Kanehiro (Kanazawa Univ., Japan). Kanazawa Irigaku Sosho, 78: 32-56(Jan. 1967). (In Japanese).

Changes of cell area of leukocyte isolated by centrifugal sedimentation were measured under various osmotic pressures and hydrogen ion concentrations and maximum and minimum values of rapid resistance of leukocytes were calculated. Pseudoeosinophilic rabbit leukocytes were irradiated in vitro and in vivo with ^{60}Co γ rays at doses of 300 to 2000 R. Both irradiated and control leukocytes were observed for 60 minutes in vitro or 28 days in vivo. No change in resistance to irradiation in vivo was observed. With regard to pH, irradiation decreased the minimum resistance slightly in the in vitro experiments, but did not give rise to change in the in vivo experiments. The results seemed to suggest that change of cell area of leukocytes was due to inadaptability of leukocytes to changes in the medium following changes in leukocyte function instigated by irradiation. (TSS)(NSA of Japan)

14257 EFFECTS OF LOW DOSES OF FRACTIONATED IRRADIATION ON THE PHAGOCYTIC FUNCTION OF THE RES IN RATS. Antonijevic, Milos (Boris Kidric Inst. of Nuclear Sciences, Belgrade). Strahlentherapie, 136: 626-31(Nov. 1968).

Phagocytic function of the RES has been studied by colloid-carbon injection in rats exposed to single dose of 300 R and fractionated doses of 3 × 100 R spaced at 10-day intervals. The results have shown that doses of 100 to 300 R induce an increase in phagocytic activity; subsequent fractions of 100 R diminish the phagocytic activity during the first two days with a later increase. A significant difference in pattern of global phagocytic index in the acute period was observed by comparing the phagocytic ability of rats receiving single dose of 300 R and total accumulated dose of 300 R: it was increased in single irradiated rats during the first days. On the other side, single and accumulated doses of 300 R did not cause essential difference in behavior of global phagocytic index in the postacute period with regard to different mode of exposure. (auth)

14258 EFFECT OF X-IRRADIATION UPON THE DEVELOPING EYE AND THE MECHANISM FORMING MALFORMATIONS

OF THE EYE. Sakurai, Tsuneyoshi (Nagoya Univ., Japan). Senten Ijo, 8: 1-11(Mar. 1968).

Mice of the ddN and CF#1-JCL strain were subjected to a single whole body x irradiations of 200 R and 300 R from day 7 to 12 of gestation. In the ddN strain, abundant eye malformations were produced in those treated on day 8 and 11 while in the CF#1 strain the peak of the eye malformations produced was only on day 7. Following x irradiation of 200 R on day 11 embryos were taken out 6, 12, 18, and 24 hours after the treatment. Thereafter, fetuses were also taken out at one-day intervals. Microscopically, cellular necroses were evident in the primordial retina, especially in the internal layer of it. Debris eliminated by phagocytes continued 24 hours after x irradiation in the ddN strain. However, such debris were continuously seen until 48 hours when the repair was completed. However, in the CF#1 strain, the involved eye presented an almost normal appearance 24 hours after the treatment. In the CF#1 strain, the eye in treated embryos was normally developed while in the ddN strain, the size of the eye was apparently small or the development was retarded suggesting sequential microphthalmos. It was concluded that the above divergences may be caused by differences in developmental potencies between these two strains of mice. (NSA of Japan)(TSS)

14259 CHANGES IN CELL POPULATION OF THYMUS, LYMPH NODES, AND BLOOD AFTER X-IRRADIATION. Sato, Chikako (Tohoku Univ., Sendai). Nippon Igaku Hoshasen Gakkai Zasshi, 27: 1529-36(Mar. 1968). (In Japanese).

Total-body x irradiation was carried out on female dd mice at 30 days of age. Mice were killed at 1, 2, 3, 5, 7, 10, and 12 days after irradiation to examine quantitatively the depletion and regeneration of cells in the lymphoid organs. The thymus and the axillary, brachial, cervical, and mesenteric lymph nodes were prepared as a cell suspension in physiological saline. The number of cells in the suspension was counted with a hemocytometer. The results were as follows: Depletion rates of total cells during 24 hours after irradiation were almost constant irrespective of the doses of 260, 410, and 690 R. Cell reproduction rates after various doses were also constant but were consistently greater in the thymus than in the lymph nodes. Longer suppression of lymphoblasts reproduction was noted with larger dose. The relation between the number of surviving cells and dose at 2 days of exposure was exponential. Small lymphocytes in whole blood of control mice were calculated to be 7×10^8 cells, and it decreased to 2 to 8×10^5 cells in one day after exposure. It recovered slowly and did not reach more than 2×10^8 cells even after 12 days of irradiation, when the thymus was fully regenerated and producing about 2×10^7 small lymphocytes every day. These results support the view that the thymus does not contribute as source for small lymphocytes which migrate to blood or lymph nodes and repopulate them. (NSA of Japan)(TSS)

14260 EFFECT OF X-IRRADIATION ON RAT THYMOCYTES IN VITRO. Araki, Kimiko (Tokyo Women's Medical Coll.). Tokyo Joshi Ika Daigaku Zasshi, 38: 467-73(July 1968). (In Japanese).

The x radiosensitivity of cultured rat thymocyte metabolism was investigated with regard to rat strain. Wistar-Imamichi strain rats were used in this study. In previous studies, Sprague-Dawley rats were used. There was no difference in concentration of lactate between control and irradiated suspensions after incubation for one hour; however, the concentration was constantly higher in the irradiated suspensions after two hours incubation. This difference became greater as incubation periods were prolonged. The conversion of ^{14}C-glucose into members of citric acid cycle increased following irradiation. (TSS)(NSA of Japan)

14261 STUDIES ON SINGLE MASSIVE IRRADIATION UNDER HYPOTHERMIA. PART 1. EXPERIMENTAL STUDY. Chisuwa, Yoshitaro (Shinshu Univ., Japan). Shinshu Igaku Zasshi, 15: 905-19(Dec. 1966). (In Japanese).

Yoshida's sarcoma subcutaneously transplanted in the left thigh of male rats of the Donryu strain were irradiated at single massive doses at 20 to 25°C (rectal temperature). The change in DNA content and the histological picture of tumor cells was studied. Fibrogenesis of tumor stroma was seen at 24 hours after irradiation in hypothermia (HY) group and at 48 hours in the normal temperature (NT) group when the dose was under 1500 R. At doses under 3000 R, fibrogenesis was observed 24 hours after irradiation and remained clear even after 48 and 96 hours in the HY group. The occurrence of giant cells was more frequent and earlier in the irradiated HY group. The changes in tumor cells were larger in the NT-group at doses below 1500 R; there was no difference between the two groups irradiated at doses under 3000 R. The DNA content of tumor cell nuclei that appeared not to have been destroyed after irradiation was measured. There were many nuclei with small quantities of DNA 6 hours after irradiation in both the HY and the NT groups at doses under 1500 and 3000 R; with lapse in time, DNA-content increased. The DNA content of tumor cells in the HY group after 48 hours was the same as that in the NT group after 24 hours. Cell division appeared to be retarded under the conditions of hypothermic irradiation. Nuclei with large quantities of DNA started to appear 6 hours after irradiation in the HY group and at 24 hours in the NT-group. (TSS) (NSA of Japan)

14262 EFFECT OF IRRADIATION TO THE CENTRAL NERVOUS SYSTEM UPON THE MOVEMENT OF THE DISTAL COLON. Kawakami, Masazumi; Negoro, Hideo (Yokohama City Univ., Japan). Yokohama Med. Bull., 19: No. 3, 63-73(June 1968).

The effect of ^{60}Co γ irradiation of the central nervous system on the movement of the large intestine was investigated in rabbits. Enterostomy was carried out at the colon and intestinal movement was recorded by means of an electric manometer using a balloon that was inserted into the large intestine. Doses of 100, 200, 500 and 1000 R were applied to the head, spinal cord, and the large intestine. During the experiment the rabbits were free to move around on an observation table. The observation period was 12 to 24 hours. When 100 to 1000 R was applied to the head, the movement of the large intestine was noticeably reduced after a latent period of approximately one hour. This change continued for 2 or 3 hr after irradiation at 100 R and for over 24 hours after irradiation at 1000 R. In all cases, intestinal motility returned to normal. When the thoracic and lumbar segments of the spinal cord were irradiated, the intestinal movement was also reduced. When the sacral segment of the spinal cord was irradiated, the motility of the large intestine was accelerated. When the large intestine was irradiated locally, even at 1000 R its movement was not affected. After removal of the sympathetic nerve supply to the large intestine, the intestinal movement was not influenced by head irradiation at either 500 or 1000 R. After removal of the parasympathetic nerve supply, the movement of the colon was reduced equally when the whole-body or head irradiation was carried out. From these findings it was concluded that a moderate radiation dose had a stimulating effect on the function of both sympathetic and parasympathetic nerve supplies and that the former appeared to be more sensitive than the latter. (TSS) (NSA of Japan)

14263 INFLUENCE OF X-IRRADIATION UNDER HYPOTHERMIA ON THE FUNCTION OF RETICULOENDOTHELIAL SYSTEM. Narai, Tsutomu (Shinshu Univ., Japan). Shinshu Igaku Zasshi, 16: No. 1, 44-67(Feb. 1967). (In Japanese).

Albino male rabbits weighing 2.5 to 3.0 kg were subjected to single whole-body irradiation at doses of 500, 1000, and 1500 R at normal temperature (NT) and at hypothermic temperatures. The function of the reticuloendothelial system (RES) was then studied by the Adler-Reimann method. Also, the changes in the peripheral blood picture were studied. Under hypothermic conditions, the function of the RES was temporarily suppressed immediately after the fall of body temperature (BT); gradual recovery occurred as BT returned to normal and remained normal after 2 weeks. Changes in the peripheral blood included increase of hemoglobin content and erythrocyte count, decrease in content of plasma protein, and marked decrease of leukocyte count. Changes were observed immediately after the fall in BT and then reverted to normal after 2 weeks. At a dose of 500 R, the function of the RES was less impeded and recovery occurred sooner at hypothermic temperatures than at NT. Blood findings, such as leukopenia, also recovered sooner at hypothermic conditions. At 1000 R, the impediment of the RES function tended to increase gradually from the 1st week after irradiation at NT. At hypothermic temperatures, the impediment was slight and recovery was good. The RES function became normal 4 weeks after irradiation. The blood picture became normal during the 4th week following hypothermic irradiation. In surviving cases irradiated at 1500 R, the RES function practically collapsed at NT; at hypothermic temperatures, this impediment was somewhat slighter. In the blood picture, recovery was somewhat better under hypothermic conditions. (TSS) (NSA of Japan)

14264 RADIATION DEATH OF CONTINUOUS X-RAY IRRADIATION IN MICE. PART 2. EFFECTS ON PERIPHERAL BLOOD. Ikeda, Yoshiharu (Hiroshima Univ.). Hiroshima Daigaku Igaku Zasshi, 15: 281-93(Apr. 1967). (In Japanese).

Male mice of ddN-strain weighing 20 to 25 gm were subjected to whole-body daily x irradiation at doses of 50 to 10,000 R/day. The erythrocyte count, hemoglobin content, hematocrit, leukocyte count, lymphocyte count, and granulocyte count of the peripheral blood were were studied. The erythrocyte count decreased gradually between 50 R/day and 300 R/day; however it increased somewhat between 800 R/day and 10000 R/day. The increase was considered due to the heme concentration induced by the massive radiation doses and was also deduced from hematocrit results. Hematocrit decreased gradually between 100 R/day and 300 R/day, but between 800 R/day and 10000 R/day it decreased in the earlier stage and increased in the later stage. The hemoglobin content fluctuated nearly parallel with the change in erythrocyte count. In all groups,

the leukocyte count decreased markedly in the early stage, then decreased gradually, until it became nil. The period from the beginning of irradiation to nil was 30 days under 50 R/day, 10 days under 100 R/day, 7 days under 200 R/day, 5 days under 300 R/day, and 3 days under 1000 R/day. The mice remained alive for some time even after the leukocyte count was nil. The lymphocyte count decreased drastically from the 1st day in all groups and continued to decrease steadily. The granulocyte count increased or was unchanged on the 1st day; on the 2nd day, as the daily dose increased, it was unchanged, decreased slightly, or decreased markedly. On the 3rd day and thereafter the granulocyte count decreased markedly and finally became nil in all groups. (TSS) (NSA of Japan)

14265 EFFECT OF X-RAY ON EXPERIMENTAL INFLAMMATION OF SUBCUTANEOUS CONNECTIVE TISSUE. Hosono, Minoru (Kanazawa Univ., Japan). Kanazawa Irigaku Sosho, 79: 51-79(May 1967). (In Japanese).

In order to study the effect of x irradiation on the inflammation of subcutaneous connective tissue, croton oil diluted 5 times was painted on the back of a mouse to cause experimental inflammation. X irradiation at doses of 50 R, 150 R, and 300 R was given before and after the painting in a single whole-body dose. Changes in the abundance of fibrocytes, leucocytes, and round cells in the subcutaneous tissue were followed for 13 days after the onset of inflammation and compared to those in control animals. In general, x irradiation slowed the increase in abundance of all cell types at the time of inflammation. Normal values generally returned within 5 days. It was concluded that x irradiation inhibited the appearance of inflammation, the inflammatory reaction to the minimum, and accelerated the consumption, generally giving a therapeutic effect. Round cells seemed to be important in the mechanism. (NSA of Japan) (TSS)

14266 SURVIVAL OF TYPE A SPERMATOGONIA FOLLOWING X-IRRADIATION. Clow, Duane James. Fort Collins, Colo., Colorado State Univ., 1968. 122p.

Thesis.

A quantitative study of the number of type A spermatogonia surviving four days after a single exposure to the testes of 800 R, 1000 R, 1200 R, 1400 R, or 1600 R was made on albino Sprague-Dawley descendant rats. The mean percentage survival of type A spermatogonia surviving was 13.72, 7.75, 4.92, 2.78, and 1.63 for the exposures 800 R, 1000 R, 1200 R, 1400 R, and 1600 R respectively. The percentage of type A spermatogonia surviving each exposure was calculated and a survival curve plotted. Survival curve parameters were estimated. A value of D_0 of 380 R was obtained with a 95 percent confidence interval of 365 R to 395 R. The extrapolation number was estimated to be 1.12 with a 95 percent confidence interval of 1.08 to 1.15. The testes were proposed as an excellent in vivo system for demonstrating radiobiological principles in a rapidly proliferating cellular system. The effect of ionizing radiation locally on the testes is due to the radiation and not due to some distant effect on another organ which then manifests its damage in the testes. (Diss. Abstr.) (TSS)

14267 RADIATION DEATH ON CONTINUOUS X-RAY IRRADIATION IN MICE. PART 1. SURVIVAL CURVE. Ikeda, Yoshiharu (Hiroshima Univ.). Hiroshima Daigaku Igaku Zasshi, 15: 271-9(Apr. 1967). (In Japanese).

Male mice of ddN-strain, weighing 20 to 25 g were subjected to continuous whole-body x irradiation at a daily dose of 50 to 10000 R until death. When the lethality was used as an index, the mean survival time of mice subjected to continuous whole-body irradiation decreased gradually with increase of the daily dose. The survival curve had 4 different phases. Between 50 R/day and 200 R/day, the mean survival time rapidly decreased as the dose increased. It was thought that the primary cause of death in this phase was the well-known hematopoietic impediment. Between 200 R/day and 1000 R/day, the mean survival time gradually decreased as the dose increased. The death in this phase was felt to be due to gastrointestinal impediments rather than to hematopoietic impediments. Between 1000 R/day and 8000 R/day, the mean survival time did not decrease with the increase of dose; the curve in this phase was a plateau. Death in this phase was considered to be due mainly to gastrointestinal impediments or the 3.5 days' effect. Between 8000 R/day and 10000 R/day, the mean survival time again gradually decreased with increase of the dose; the death in this phase was probably cerebral death. (TSS) (NSA of Japan)

14268 A REVIEW OF THE RADIOSENSITIVITY OF THE TISSUES IN BONE. Report Prepared for Committees 1 and 2 of the International Commission on Radiological Protection. ICRP Publication 11. Oxford, Pergamon Press, 1968. 43p. 25s.

The subject is discussed under the following main headings: location and relative numbers of radiosensitive cells and of cells not considered to be radiosensitive in bone and in bone marrow; localisation of bone-seeking radionuclides and the ionisation patterns resulting from their deposition in relation to radiosensitive cells of bone and marrow; changes in the patterns of distribution resulting from growth and remodelling of bone; biological data on tumor formation and degenerative changes; consideration of the comparative tumorigenic effects of external and internal irradiation of bone; factors to be considered in determining the dose limitation from bone-seeking radionuclides; summary and conclusions. (UK)

14269 THE STIMULATING EFFECT OF LOW POWER LASER RAYS ON BIOLOGICAL SYSTEMS. Mester, E.; Ludany, G.; Selyei, M.; Szende, B.; Total, G. J. (Medical Univ., Budapest). Laser Rev., 1: 3(Mar. 1968).

The effects of laser radiation on the phagocytic activity of leucocytes, on the activity of Ehrlich ascites tumor cells, and on the skin of mice were reported. Irradiations were performed with a laser device of low efficiency, without focusing, and pulse duration of 0.5 msec. It was found that application of 1 to 4 J/cm^2 ray energy led to significant inhibition of phagocytosis, using Staph. pyogenes aureus. Mice were used for tumor cell studies, employing 0.2 to 1.0 J/cm^2; cellular activity was stimulated. In the skin tests two phases were observed; intact follicles, abundant in cells, were the characteristic histological feature of phase one, whilst destruction of the follicular cells and their inflammatory reactions were observed in phase two. It was established that, as a result of continuous prolonged treatment, the epithelium became thinner, and at the same time a focal basal cellular hyperplasia developed; also that the activity of follicular cells (increase and inhibition) depended on irradiation energy. With regard to internal organs, in one instance necrosis of the subcapsular nuclear layer of the liver and in another instance intestinal necrosis, were found. (UK)

14270 RESTORATION OF REGENERATION BY CARTILAGE IMPLANTS IN IRRADIATED LIMBS OF TRITURUS CRISTATUS. Desselle, Jean-Claude (Faculte des Sciences, Marne, France). Compt. Rend., Ser. D, 267: 1642-5(Nov. 13, 1968). (In French).

Cartilage implants labeled with ^{3}H- or ^{35}P-thymidine restore the regeneration capacity of limbs previously irradiated and then amputated. The labeling makes it possible to follow the implanted cells and to show that they participate in the formation of the cartilage and muscles of the regenerated limb. Injections of cellular preparations of cartilage origin cause the reestablishment of the regenerative capacity in irradiated and amputated limbs. (trauth)

14271 PRE-THERAPEUTIC EXPERIMENT WITH THE FAST NEUTRON BEAM FROM THE MEDICAL RESEARCH COUNCIL. 1. COMBINATION STUDY OF X-RAYS AND FAST NEUTRONS ON TUMOUR REGRESSION. Watanabe, Noritoshi; Thomlinson, R. H. (Experimental Radiopathological Research Unit, England). Nippon Igaku Hoshasen Gakkai Zasshi, 27: 1601-6(Mar. 1968). (In Japanese).

A proportion of the anoxic cells in a tumor can be altered by changing the interval time between first dose and second dose, and by the concentration of oxygen respired during x irradiation using RIB 5 tumor. This was done to determine the fast neutron RBE value and to estimate the optimal time interval between doses. All the materials and methods used in this experiment have been described previously. The tumors were transplanted to form spherical masses beneath the skin of the middle portion of the abdomen. When they had attained a size of between 8 and 10 mm in diameter, they were irradiated with fast neutrons at 700 rads first and then with 250 kV x rays, just 24 hours later. In these experiments 64 tumors were used. Second irradiation with x rays was given when the animals were breathing air, pure oxygen at 3 atmospheres, and when the tumors had been made anoxic by circulation clamping. The results of irradiation have been determined from daily measurement of the diameters in each dimension and from the mean time taken by each group of tumors to grow to the arbitrarily chosen diameter of 20 mm. As the result of this investigation, the RBE of tumor RIB 5 was estimated in the order of 2, and the optimal time-interval between fast neutron and x ray was more than 24 hours. (TSS) (NSA of Japan)

14272 STUDY ON ANEMIA INDUCED BY X-RAY RADIATION. Hada, Yoshihiro (Okayama Univ., Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 27: 1217-29(Dec. 1967). (In Japanese).

Male rabbits weighing about 2.5 kg were exposed to whole-body x irradiation of 1000 R in order to study the post-irradiation anemia. It was found that the post-irradiation fluctuations of RBC, WBC and reticulocyte counts in these animals seemed to be nearly the same as those previously reported by other investigators. As for the erythrocyte resistance of hypoosmotic saline there was observed only an initial decrease in the osmotic fragility after 6 hours and recovery after 24 hours. The erythrocyte survivals as

measured by the ^{51}Cr method revealed that the red blood cells in an irradiated host had no shortening of survival time in comparison with that of control group when transfused into non-irradiated rabbits, but red blood cells irradiated in vitro showed a marked shortening of the survival time when transfused into nonirradiated one. On the other hand, red blood cells from both irradiated and non-irradiated rabbits showed a moderate prolongation of survival time when injected into previously irradiated animals. Therefore, it is reasonable to assume that the ionizing radiation effect on erythrocytes may not be direct, but indirect, perhaps through the variation in serum properties. The serum iron measurement revealed a rapid decrease within the first 6 hours accompanied by a subsequent increase to 1.5 times of preirradiation level for 24 to 48 hours. Relative to the ^{59}Fe injected in the form of ^{59}Fe-globulinate, the plasma iron disappearance (PIDT 1/2) was considerably prolonged in rabbits immediately after the irradiation and the plasma iron turnover rate or the red cell utilization was also markedly disturbed by x radiation. There was little change in the serum lecithin level but a slight decrease (corresponding to about 10% of preirradiation level) occurred within the first 1 to 12 hours, which showed an increase (corresponding to 20% of preirradiation level) by the tenth postirradiation day, and thereafter a decrease seemed to coincide with the onset of the decrease in the number of erythrocytes. These results seem to indicate that the formation of lysolecithin, which has tremendously strong hemolytic activity was elicited by catalysis of phospholipase A. However, it is premature to conclude definitely the lysolecithin formation on the basis of these observations only. (TSS) (NSA of Japan)

14273 EFFECT OF ADRENOCORTICAL REACTIVITY ON THE COURSE AND OUTCOME OF EXPERIMENTAL RADIATION SICKNESS. Fedotov, V. P.; Moroz, B. B.; Dubrovin, A. D. Probl. Endokrinol. No. 1, 68-71(1968). (In Russian).

Research was conducted to prevent an extreme rise in the corticosteroid level of rat blood by artificially reducing adrenocortical reactivity, and to evaluate the effect of such action on the course and outcome of acute radiation sickness. Adrenocortical reactivity was reduced by administering prednisolone for 10 days before irradiation, by autotransplanting the adrenal glands, and by adrenalectomy. Autotransplantation and adrenalectomy were performed 30 days before irradiation. Irradiation (55 R, dose rate 160 R/min) produced the typical picture of acute radiation sickness in all the animals. The course was severest in the adrenalectomized rats. Rats with autotransplanted adrenals proved to be most resistant to the radiation, as reflected in the milder course of the disease, better hematological indices, and lowest death rate. The high death rate of the adrenalectomized animals shows that a very low corticosteroid level which can preserve the lives of nonirradiated animals does not maintain the adaptive processes in the irradiated organism. It seems that both a deficiency and an excess of adrenocortical hormones aggravates the course of acute radiation sickness. (auth)

14274 INFLUENCE OF HEAT UPON RADIODERMATITIS. Seki, Susumu (Shinshu Univ., Japan). Shinshu Igaku Zasshi, 16: 359-74(Feb. 1967). (In Japanese).

The skin of male mice of Wistar strain weighing 150 to 200 g was warmed up to 38°, 40°, or 42°C and x irradiated with doses of 300 R, 500 R, 1000 R, or 2000 R, in order to examine the macroscopic and histological changes in the skin and skin function. The results obtained are as follows: In macroscopic observation of the skin, the degree of change is far greater in the group irradiated with warming than in the group irradiated under normal temperature (N.T.). Erythema appears at the dose of 500 R under N.T., but under 40°C it is observed even at 300 R. Erosion is seen at 2000 R under N.T., but under 42°C it appears even at 300 R. Ulcer is not seen under N.T., but it is formed at 1000 R under 42°C. In order to measure skin function, the methylene blue intracutaneous reaction was examined. With the same radiation dose, the higher the skin temperature, its disappearance time becomes the shorter and the time after irradiation required for its return to normal value becomes greater. Histologically, the change of epidermis and hair follicles after x irradiation are greater under high temperatures than under N.T. Considerable change in hair follicles appears at 1000 R under N.T., but under 40°C it is observed at 500 R. In epidermis, necrotic inflammation is observed even at 300 R under 42°C on the 3rd day after irradiation, but under N.T. it is not seen unless the radiation dose exceeds 2000 R. (TSS) (NSA of Japan)

14275 EFFECT OF FOOD AND WATER DEPRIVATION ON THE PERIPHERAL BLOOD PARAMETERS OF THE MOUSE. Archambeau, J. O.; Stryckmanns, P.; Brenneis, H. (Brookhaven National Lab., Upton, N. Y.). Radiat. Res., 36: 396-409(Dec. 1968).

Various peripheral blood and bone marrow parameters were determined during food and water deprivation and during food deprivation alone in order to obtain base lines that may be used to make comparisons with similar data from irradiated mice. The peripheral blood parameters following food and water deprivation were similar to those following food deprivation alone. The mean survival time was about 5 days and the weight loss 40% of the control weight. There was an absolute decrease in the total circulating lymphocyte and platelet counts, while the total granulocyte count remained unchanged or increased. The blood volume decreased, while the hematocrit and specific gravity of the blood increased. The bone marrow parameters following food and water deprivation showed that erythropoiesis was more markedly depressed than myelopoiesis. The tritiated thymidine labeling index for granulopoietic cells and megakaryocytes decreased progressively during starvation. The variations in the white blood count and the bone marrow parameters are not comparable with those found in irradiated mice having the G.I. syndrome; the changes in mean survival time, weight loss, hematocrit, and blood volume are similar. (auth)

14276 INDIRECT EFFECT OF X-IRRADIATION ON EMBRYONIC DEVELOPMENT: UTILIZATION OF HIGH DOSES OF MATERNAL IRRADIATION ON THE FIRST DAY OF GESTATION. Brent, Robert L.; Bolden, Booker T. (Jefferson Medical Coll., Philadelphia). Radiat. Res., 36: 563-70(Dec. 1968). (NYO-2071-42).

Two hundred and eighteen female rats were utilized in this study to evaluate the indirect effect of maternal x-irradiation on embryonic development and survival. There were two control groups and ten experimental groups receiving 0, 60, 150, 275, or 400 R on the afternoon of the first day. The use of special shielding devices permitted irradiation of either the mother or the zygote. Several groups of pregnant rats were exposed to 150 R on the afternoon of the first day of gestation. Irradiation of the oviduct and the ova resulted in a 60 to 70% resorption of the implanted ova. Irradiation of the maternal organism while the oviduct was shielded did not increase the resorption rate above control levels. Thus, no indirect effect was demonstrated when the maternal organism received 150 R. When the maternal rats received 400 R and the ova were shielded, 25% of the implanted embryos resorbed. This was apparently not due to leakage of radiation around or through the special shielding. Thus, high doses of radiation in the rat have a moderate indirect effect, but this indirect effect first becomes manifest when the dose of radiation is above the LD_{50} following direct irradiation of the ova. Neither maternal irradiation nor zygote irradiation on the first day of gestation results in an increase in gross congenital malformations or produces fetal growth retardation. (auth)

14277 RADIOIODINE DISTRIBUTION IN THE ORGANISM IN ENDOTRACHEAL ADMINISTRATION AND MORPHOLOGICAL CHANGES IN THE THYROID GLAND IN EXPERIMENT. Korolev, G. K.; Serebryakov, N. G.; Tkachev, A. V. (Inst. of Medical Radiology, Moscow). Med. Radiol., 13: No. 11, 59-64(Nov. 1968). (In Russian).

Experimental studies conducted on Wistar rats with endotracheal administration of ^{131}I established that 80% of its quantity departed from the lungs in T_{eff} – 40 min and 20% in T_{eff} – 1 day. Radioiodine accumulation in the gland occurred during 24 hours. The isotope was eliminated from the organ slowly, T_{biol} – 44 days. Reduction of the activity in the organ took place mainly at the expense of physical break up of the isotope. This conditioned an effective period of semidischarge equalling 7 days. Histoautoradiographic data showed that radioiodine at the beginning enters the follicular epithelium, then concentrates in the colloidal substance. Radioiodine in quantities of 0.01 and 0.1 μCi/g causes functional changes in the thyroid tissue, characterized by decrease of its activity. This is seen by the appearance of flattened epithelium in follicles. The administration of 0.5 μCi/g leads to degenerative changes in the epithelium and death of most of follicles. (auth)

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Refer also to abstracts 14149–14153, 14222, 14223, 14235, and 14255.

14278 (AGARD-CP-25) BEHAVIOURAL PROBLEMS IN AEROSPACE MEDICINE. Papers Presented at the Twenty-Fourth Meeting of the Aerospace Medical Panel of AGARD, held in Rhode-Saint-Genese, Belgium, 25-27 October 1967. (Advisory Group for Aerospace Research and Development, Paris (France)). Oct. 1967. 428p. (In English and French). (CONF-671059).

The 24th Meeting of the AGARD Aerospace Medical Panel dealt with behavioral problems of aerospace medicine, with particular reference to such aspects as diurnal rhythms, sleep, and alertness. Recent medical problems of space and of air warfare were also considered. The subject of sleep and wakefulness, based on a

24 hr cycle, was considered in relation to man's performance. Emphasis was placed on the practical aspect of these circadian problems, particularly in relation to associated changes in reaction time and mental performance, and in relation to civil and military aviation. The quality of sleep, and the biochemistry underlying the choice of sleep-inducing drugs were discussed. Other subjects, such as the biological effects of cosmic radiation on bacteria and mice, and the ability to walk in a lunar environment, as tested by the Langley sub-gravity simulator, formed part of the section dealing with current problems of space, while other papers discussed a variety of topics, many of which were oriented towards a specialist audience. A model for retinal damage induced by pulsed lasers is presented. The development of protective clothing for aircrews in hot, humid environments and the development of eye glasses for protection against flashblindness are described. An aircrew selection test, and the effect of a five weeks' stay at 2,250 metres altitude on some aspects of pulmonary function are included. (auth) (TSS)

14279 A FOLLOW-UP OF 1000 THOROTRAST CASES IN DENMARK. Faber, Mogens (Finseninstitutet og Radiumstationen, Copenhagen). pp 1521-4 of Radiation Protection. Part 2. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.2)).

A series of Thorotrast-injected patients has been followed in Denmark since 1949. The series now numbers 1000 patients of which 510 are still alive. The follow-up is performed through hospital contacts and is activated by notice of death. Some patients have been seen but only as a neurosurgical follow-up. All patients have had a neurosurgical carotid arteriography. Record of death is verified from the physicians, hospital records and autopsy records. The most common cause of death is of course the neurosurgical diseases of which some 300 have died. Non-malignant diseases of other organs have been the cause of death in 150 cases, and 40 cases of malignant diseases have been observed. Among the non-malignant diseases there has been observed a number of bone-marrow discrasias of non-leukaemic type but amazing few signs of serious hepatic disorder. The total number of malignant diseases is very close to the one expected from cancer statistics in Denmark. However, 4 hemangioendotheliomas and 8 leukemias have been met with, both a definite increase above expectation. The number of primary hepatic tumors are also slightly above expectation. The significance of these results will be discussed in relation to other comparable materials. (auth)

14280 DEVELOPMENT OF RADIATION CATARACT AFTER EPIBULBAR IRRADIATION OF THE EYE WITH ^{90}Sr. Notter, Gustaf; Ruden, Bengt-Inge; Zetterquist, Birgitta (Karolinska Institutet, Stockholm). Strahlentherapie, 136: 529-36(Nov. 1968). (In German).

Control ophthalmologic examinations performed in 26 patients treated by ^{90}Sr application for epibulbar lesions, disclosed four partial cataracts induced by the radiation. None of these provoked vision reduction. They were all in form of a sector and situated within the radiation field, at the periphery of the lens equator. One showed beginning of opacity at the anterior and posterior pole. The minimal dose causing cataract in these cases was 2000 rad in 24 months, whereas in one case 1200 rad in 61 days and in three cases 960 rad in 5 to 6 days did not cause any cataract. An increase of the frequency of cataract after a longer observation time was not found. Dose rate and dose distribution of the applicator was determined with thermoluminescence dosimeters. (auth)

14281 STUDIES ON SINGLE MASSIVE IRRADIATION UNDER HYPOTHERMIA. PART 2. CLINICAL STUDY. Chisuwa, Yoshitaro (Shinshu Univ., Japan). Shinshu Igaku Zasshi, 15: 920-35 (Dec. 1966). (In Japanese).

The effect of radiotherapy on blood properties, liver functions, skin, and tumors of 20 patients were studied following 26 applications of single massive irradiation (1000 to 5000 R) under hypothermia (28.9°C). No marked fluctuations were observed in hemoglobin content, erythrocyte count, blood and plasma specific gravity, and hematocrit. The leucocyte count decreased after irradiation and recovered after 4 weeks. The thrombocyte count decreased 3 days after irradiation and recovered about a week after; the lymphocyte count decreased after 3 days. No marked changes were observed in serum protein, serum electrolytes, and liver functions. Total cholesterol increased temporarily after irradiation of the body trunk and decreased slightly after 2 to 3 weeks; it increased after 4 to 5 weeks and then returned to normal. Even when irradiated at a single massive dose of 1000 to 5000 R, an ulcer did not form on the skin under conditions of hypothermia; erosion appeared in 4 of 20 cases. Postirradiation conditions had no influence at all upon wound healing and no radiation sickness was observed. Histologically, the reactions such as necrosis of connective tissue and telangiectasis were slight under hypothermic irradiation as compared with the normal temperature irradiation. The change of tumor cells was nearly the same under both conditions of irradiation. The fibrogenesis of stroma was more marked under hypothermic irradiation. It was concluded that hypothermic irradiation was suitable for preoperative irradiation of malignant tumors. (TSS) (NSA of Japan)

14282 REMOTE SEQUELAE OF IRRADIATION OF DIENCEPHALON IN MAN. Domshlak, M. P.; Tereshchenko, N. Ya.; Raevskaya, S. A.; Zyuzin, I. K. Med. Radiol., 13: No. 11, 19-24(Nov. 1968). (In Russian).

A total of 26 subjects underwent a clinical and a thorough clinical and physiological examination 8 to 10 years after irradiation of the diencephalon; indirect x-ray therapy had been used to treat skin diseases. The temple had been chosen as an exposure field, its size being 16 cm^2, and the left and the right temple had been irradiated alternatively. A single exposure dose had been 150 rad, while the total dose for 20 subjects had been 900 rad and for 6 subjects—600 rad. The absorbed focal dose had respectively been 540 and 360 rad. After a long time lapse, reliable shifts were brought out involving a number of clinical, as well as clinical and physiological indices. The shift evidenced a change in the functional state of both the higher involuntary centers and other branches of the involuntary nervous system. (auth)

Radiation Effects on Plants

Refer also to abstracts 14142, 14148, and 14290.

14283 RADIOSENSITIVITY OF SUNFLOWER SEEDS TO GAMMA RAYS IN ALBINO AND GREEN PLANTS. Sizova, L. I. (Univ. of Rostov-on-Don, USSR). Genetika, 4: No. 12, 156-9 (Dec. 1968). (In Russian).

The objective of these studies was to determine the difference between green and albino sunflower plants in the sensitivity of the seeds to γ rays. The seeds of both the green and the albino plants (of the types Xantha and Lutescens) were irradiated at dosages of 1, 2, 3, 5, 10, 15 and 20 kr. The source of γ rays was ^{60}Co. The criterion for determining the radiosensitivity of the nuclear apparatus was the proportion of injured cells that increased with the increasing irradiation dosage: in complete albinos—from 3.65% to 81.32%; in incomplete albinos—from 3.16% to 77.85%; in green plants—from 2.56% to 65.80%. A conclusion is drawn that the seeds of the albino plants are more radiosensitive than those of green plants, the type xantha (complete albinos) being the least resistant of the two albino types. (auth)

14284 DEVELOPMENT OF TEST SYSTEMS FOR USE IN RADIOBIOLOGY. Cercek, Lea; Foster, J. L.; Haigh, Mary V.; Howard, Alma (Christie Hospital, Manchester, Eng.). J. Physiol. (London), 197: 55P-6P(July 1968).

The filamentous green alga Oedogonium cardiacum was used to study cell death after single and fractionated doses of irradiation and also the effect of various gases combined with x rays on cell death. Spores of the fern Osmunda regalis were tested to assess the effects of irradiation on cell survival and as a producer of mutations and chromosome structural damage. The effects of O_2 and other chemical agents which may enhance the radiation effect, dose fractionation, and relative biological effectivity were also studied with this material. Barley, Hordeum vulgare, was used to study the effects of neutron irradiation. Enhancement of radiation effects by O_2 and studies of relative biological effectivity were made by measuring the effects of radiation on root, coleoptile and leaf growth. Roots of the broad bean Vicia faba were used to study the effects of radiation on a dividing cell population. Reduction in the rate of growth and chromosome damage were observed. Mouse skin melanocytes were used to construct cell survival curves after varying doses of radiation. Enhancement of radiation effect by O_2 and fractionation studies were also studied in this system. (BBB)

14285 STUDY OF SPROUTING OF PHASEOLUS VULGARIS L. SEEDS TREATED WITH RADIOACTIVITY AND PHOTOSENSITIZING DYES. THE COURSE OF SPROUTING COMPARED BETWEEN AT MOUNTAIN HEIGHT (MT. NORIKURA) AND AT SEA-LEVEL. Yamashita, Shinichiro; Suga, Sadaharu (Japanese Research Inst. for Photosensitizing Dyes Co., Ltd., Tokyo). Sanyo Gijutsu Zasshi, 22: 32-5(Mar. 1968). (In Japanese).

Sprouting and growth of Phaseolus vulgaris L. seeds were observed for a period of approximately 3 weeks at the heights of Mt. Norikura. The seeds which had been immersed in radioactive water and a solution of photosensitizing dyes (platonin and neoxin) showed a quite normal course of growth, whereas non-treated seeds showed a very poor sprouting at the heights. The growth

of the treated seeds at the mountain-height demonstrated a slight delay (only several days) as compared with that tested at the same time at sea-level (at Ise City, Mie Prefecture). (NSA of Japan)

Radiation Effects on Microorganisms

Refer also to abstracts 14134, 14135, 14147, and 14226.

14286 (COO-1183-30) GROWTH CHARACTERISTICS OF TYPE E CLOSTRIDIUM BOTULINUM IN THE TEMPERATURE RANGE 34 TO 50°F. Annual Report, January 15, 1968. (Continental Can Co., Inc., Chicago, Ill. Metal Div. Research and Development). Oct. 15, 1968. Contract AT(11-1)-1183. 43p. Dep. CFSTI.

Studies on the potential health hazard of Clostridium botulinum in irradiated fresh haddock were conducted. The samples were given 0.1 and 0.2 Mrad irradiation doses and incubated at either 50, 46, 42, 40, or 38°F along with inoculated unirradiated control samples, and toxin assays were conducted. Resistance of spores of the Beluga strain to γ radiation was determined in haddock homogenate and in TPG medium. The results suggested that TPG medium may be a suitable substrate to simulate marine or other food products for preliminary determination of the radioresistance of spores. Tables are presented to show toxin production in irradiated and unirradiated haddock at various temperatures. (H.L.W.)

14287 (TID-24780) PHYSIOLOGICAL STUDIES ON CLOSTRIDIUM BOTULINUM, TYPE F. Progress Report, March 1-November 39, 1965. Walls, Nancy W. (Georgia Inst. of Tech., Atlanta, Engineering Experiment Station). Contract AT(40-1)-3347. 82p. Dep. CFSTI.

Five different strains of Clostridium botulinum, type F, were used to perform experiments on the ability of this organism to grow and produce toxin at low temperatures. The strains used were: Langeland, OGB-69, OGB-69R, TOX-IB, and OPY-26. The Langeland strain is the original strain isolated in nature from a fatal case of botulism in Denmark and the other four strains are laboratory variants of the Langeland strain. Low temperature studies were performed in the 4°C to 10°C range since this is the temperature range encountered in actual refrigerated storage of marine products. Media used were fish homogenate, cooked meat, trypticase, soytone, and type C toxin medium. The parameters of growth were development of turbidity in cultures and changes in the morphological character of individual cells as determined by microscopic examination. It was found that the different strains of C. botulinum, type F, varied in their ability to grow at 4°C or 10°C depending on such factors as the type of growth medium chosen, the volume of inoculum used to initiate growth, and the specific temperature of incubation. All strains tested were capable of some growth at temperatures in the 4°C to 10°C range. Maximum toxicity levels obtained were of the order of 2×10^4 LD_{50} per ml. This was in trypticase medium at 30°C. Much lower toxin levels were developed at low temperatures. Titers of two LD_{50} per ml could be demonstrated in cultures incubated at 4°C or 10°C. This value could be influenced by the medium chosen for growth. Toxicity of low temperature culture supernates could be increased by enzymatic activation with trypsin. Experiments were also performed on the resistance of C. botulinum, type F, spores to cesium-137 gamma irradiation. The radiation resistance of spores of the strains tested was found to be dependent on both the strain of organisms being used and the type of medium in which it was suspended. Three different media were used: M/15 phosphate buffer, nutrient gelatin, and fish homogenate medium. C. botulinum, type F, appears to be a fairly radiation resistant immunologic type, requiring a minimum of 600,000 RADS of gamma radiation to effect a 90 percent kill even in the least protective medium of those tested. A short term study was also performed on sporulation by different strains of C. botulinum, type F. It was found that the strain of organism present, the volume of culture medium in which it was being grown, and the chemical composition of the growth medium affected both the total percentage of spores produced by the culture and the heat and radiation resistance of such spores when they reached maturity. (auth)

14288 THE GENE-CONTROLLED RADIATION SENSITIVITY IN YEAST. III. ON THE INFLUENCE OF THE MATING TYPE LOCUS ON THE SENSITIVITY OF DIPLOID STRAINS TO X-RAYS AND ON THE MITOTIC RECOMBINATION. Kozhina, T. N. (Ioffe Inst. of Physics and Tech., Leningrad). Genetika, 4: No. 12, 36-9(Dec. 1968). (In Russian).

Diploid strains of the yeast Saccharomyces cerevisiae derived from the XII th race did not exhibit any influence of the mating-type locus on the sensitivity to x rays. This suggests that the aα-effect described by Laskowski is specific for the strains of certain genotypes only. No decrease in the frequency of induced mitotic recombination involving the gene-centromere regions in strains homozygous for the mating-type locus was observed. (auth)

14289 EFFECTS OF ULTRAVIOLET RADIATION ON THE ESTABLISHMENT OF ERYSIPHE GRAMINIS f. sp. TRITICI ON WHEAT. Mount, Mark S.; Ellingboe, Albert H. (Michigan State Univ., East Lansing). Phytopathology, 58: 1171-5(Aug. 1968).

Ultraviolet light was used in determining the time of the division and migration of the nucleus into the haustorium of powdery mildew (E. graminis f. sp. tritici). Susceptible wheat plants were uv irradiated for 30 and 60 sec at various times between 6 and 20 hr after inoculation with powdery mildew. The formation of functional secondary hyphae was used as a criterion for sensitivity to uv radiation. Inoculated plants irradiated between 6 and 12 hr after inoculation exhibited almost complete inhibition of the formation of functional secondary hyphae. More conidia formed functional secondary hyphae when plants were irradiated between 14 and 20 hr than when irradiated before the 14th hr after inoculation. Pustules developed after 6 days on plants irradiated at the 14th hr and subsequently, but not on those irradiated before 14 hr after inoculation. A distinct nucleus was first observed 16 hr after inoculation. The data indicated that the nucleus of the mildew fungus had divided by 14 to 16 hr after inoculation and a nucleus had migrated into the haustorium. (BBB)

Radiosterilization and Radiopreservation

Refer also to abstract 14286.

14290 (UCD-34-P-73-27) THE RADIATION PHYSIOLOGY AND MICROBIOLOGY OF FRUIT DETERIORATION. Final Report. Sommer, Noel F. (California Univ., Davis. Dept. of Pomology). Dec. 1, 1968. Contract AT(11-1)-34. 82p. Dep. CFSTI.

Studies on the effects of γ radiation alone or in combination with heat treatment, cold treatment, or anoxia on the survival of spores of fungi that incite postharvest spoilage of fruits are summarized. Results are reported from studies on Rhizopus stolonifer, Rhizopus arrhizus, and Penicillium expansum. It was concluded that the effectiveness of γ radiation for the control of the growth of fungi on fruits during storage and shipment was limited. Results are reported from a study on the effects of γ-irradiated sucrose solutions and juice and puree from γ-irradiated strawberries on the induction of chromosome aberrations in root tip cells of Vicia faba. Results showed no evidence of a mutagenic or radiomimetic effect following exposure of the preparations to doses of 200 Krad γ radiation. A list is included of 46 publications during the period covered by this report. (C.H.)

14291 BIOLOGICAL SUBSTANTIATION OF THE POSSIBILITY OF BANKING BLOOD IN PLASTIC CONTAINERS STERILIZED, TOGETHER WITH SOLUTIONS, BY GAMMA RAYS. Stakhowski, Ya. V.; Dawhalew, S. I.; Harbunow, P. Ts.; Buhhlow, Ya. D. Vestsi Akad, Navuk BSSR, Ser. Biyal. Navuk, No. 2, 87-94(1967). (In Russian).

The effect of sterlizing doses of γ rays on polyvinyl chloride and on the preservation of blood in storage, and the effects of γ-ray sterilized blood on the organism of the recipient were examined. The sterilizing effect of doses from 50 to 800 thousand R was determined. The selected dosage of 500 thousand R assures sterilization of the solution in the plastic container but causes no perceptible changes in the physical properties of the container. Solutions (sodium chloride and citrate, heparin, glucose, sucrose, distilled water) sterilized in plastic containers by means of γ rays were nontoxic and could be stored for a long time. No significant differences in the biochemical or morphological characteristics of the blood, preserved in solution sterilized with γ rays in packages and autoclaved, were noticed except for a certain reduction in the amount of catalase. Transfusion of blood thus preserved did not cause any pathological reactions in the respiratory, cardio-vascular, or hemogenic systems of the test rabbits. (ATD)

14292 TREATMENT OF FOODS WITH IONIZING RADIATIONS. Papers Presented at a Course held at Wantage Research Laboratory (UKAEA), Sept. 1965. Rhodes, D. N. (Comp.). Scientific and Technical Surveys No. 47. Leatherhead, Eng., British Food Manufacturing Industries Research Association, 1967. 32p. 25s.

Fourteen papers on principles of radiation processing, operation of irradiation plants, wholesomeness of irradiated foods, and other aspects of food irradiation are summarized. (H.L.W.) (UK)

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

Corrosion and Erosion

Refer also to abstracts 13956, 14315, and 14349.

14293 (BNWL-948) FFTF EXAMINATION FACILITY ATMOSPHERE IMPURITY CONTROL REQUIREMENTS (A REVIEW OF EXISTING INFORMATION). O'Keefe, D. P. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan. 1969. Contract AT(45-1)-1830. 28p. Dep. CFSTI.

Impurity control requirements for the protective atmosphere to be used in the FFTF Examination Cell were studied by means of literature search and consultation. The review yielded information that permits a partial definition of the atmosphere impurity control requirements for stainless steel components and indicated areas in which research and development effort is required. An argon atmosphere with limits for O_2 and H_2O of 25 ppM each, and N_2 in the 3 to 4% range as controlled by feed and bleed is sufficient protection for stainless steel components maintained at temperatures of 600°F and below. If metal temperatures are permitted to reach 1000°F, the possibility for minor nitriding exists. Caustic stress corrosion is a possible source of trouble for specimens at temperatures above 1000°F, sodium-covered, and under stress, which could be the case for uncleaned, high exposure fuel pins. (auth)

14294 (CEA-CONF-1186) KINETIC ASPECTS OF CORROSION OF STEELS IN FLOWING SODIUM. Champeix, L.; Konovaltschikoff, O. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). [1967]. 17p. (CONF-681106-13). Dep.

From Conference on Sodium Technology and Large Fast Reactor Design, Argonne, Ill.

Experiments were performed to determine the rate of corrosion of Chromesco 3 and EM 12 chromium steels and several austenitic steels in flowing sodium at 650 and 700°C for time periods up to 4500 hrs. The results are compared with a theoretical linear expression (by Lockhart) of corrosion rates as a function of time after an initial period. The results agree well with theoretical calculations and show, particularly in the case of a low percentage of 0, that the corrosion rate is steady after a long initial time and definitely after 2000 hrs. Further research on the effects of the percentage of oxygen and the speed of sodium flow are recommended. (L.C.L.)

14295 (DP-MS-67-119) HOT-SALT STRESS CORROSION CRACKING OF TITANIUM ALLOYS. Rideout, S. P.; Ondrejcin, R. S.; Louthan, M. R. Jr. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Apr. 5, 1968. 23p. (CONF-680542-2). Dep. CFSTI.

From International Conference on Titanium, London, England.

Hot-salt stress corrosion cracking in several titanium alloys was investigated to determine the relationships between susceptibility to cracking and temperature of exposure, chemical composition of the salt deposit, and alloy composition and microstructure. The alloys tested were Ti-8Al-1Mo-1V, Ti-6Al-4V, Ti-2Al-2.5Sn, Ti-4Al-3Mo-1V, Ti-8Mn, and commercial titanium. The alloys were investigated by hot-stage, optical and electron microscope studies, radiotracer techniques, mass spectrometry, x-ray diffraction, and electron microprobe analyses. These studies established that hot-salt stress corrosion cracking involves two distinct processes: crack initiation and crack propagation. Crack initiation occurs after an incubation period which depends on the temperature of exposure, chemical composition of the salt deposit, and the composition of the alloy. For a given alloy and salt composition, the incubation period increases with decreasing temperature. The presence of moisture in the salt deposit and the formation of HCl gas by hydrolysis play vital roles in the stress-corrosion process. A variety of chloride, bromide, and iodide salts can cause cracking. Radiotracer studies have shown that some corrosion-produced H_2 (^3H) is absorbed by the metal, causing embrittlement which leads to crack initiation. Crack propagation is less sensitive to temperature, and the rate of propagation in a given alloy is primarily controlled by the nature of the salt deposit and the stress level. Mass spectrometric analyses of volatile products of chloride salt corrosion indicate that the most severe cracking is produced by those salts which hydrolyze readily and thus produce a continuing supply of HCl in the crack. Fractographic studies show that crack propagation occurs by mechanical rupture (mainly quasi-cleavage) rather than electrochemical corrosion. It is proposed that crack propagation occurs by a stress-sorption mechanism and that corrosion-produced hydrogen is the sorbing species. (L.C.L.)

14296 (HW-72076) EFFECTS OF Cr(VI) AND Fe(III) ON PUREX PLANT CORROSION. Maness, R. F. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Jan. 5, 1962. Contract AT(45-1)-1350. 16p. Dep. CFSTI.

Laboratory corrosion data indicate the life of 304 L stainless steel acid waste concentrator tube bundles would be in excess of five years if Cr(VI) and Fe(III) concentrations in the IWW simulated Purex waste solution designated on IWW were reduced to insignificant values. The life of the back-cycle (H-4) simulated Purex waste solution concentrator bundle was estimated at four to five years under comparable conditions. The degree to which iron can be eliminated from plant solutions is questionable. Plant use of U(IV)-hydrazine for plutonium partitioning would reduce the iron concentration to about half its present value. A further significant reduction is possible if an alternate reducing agent can be found for neptunium recovery. However, reduction of the Cr(VI) content to an insignificant level ($\leq 5 \times 10^{-4}$M) and a two-fold reduction in Fe(III) would reduce IWW and H-4 concentrator bundle corrosion by factors of about four, i.e., to values of about one and three mils/month respectively. It is feasible to obtain and maintain a low Cr(VI) concentration ($\leq 5 \times 10^{-4}$M) by treating solutions to be concentrated with hydroxylamine (or a similar reductant) prior to concentration and, if necessary, bleeding NO_2 into the concentrators. Analysis of plant solutions would be necessary to determine the necessity of the latter step. Laboratory data indicate it is feasible to contain interim acid waste solution in 304 L provided any Cr(VI) present is reduced to Cr(III) prior to storage. Simulated boiling acid waste solution containing all chromium as Cr(III) was held at the boiling point for 625 hours with no reoxidation of Cr(III). (auth)

14297 (ORNL-4323) REFLUXING CAPSULE EXPERIMENTS WITH REFRACTORY METALS IN BOILING ALKALI METALS. DiStefano, J. R. (Oak Ridge National Lab., Tenn.). Jan. 1969. Contract W-7405-eng-26. 36p. Dep. CFSTI.

Heat engines based on nuclear reactors have been proposed as a source of electrical power for space vehicles. Since alkali-metal-cooled reactors are promising for this application we studied the corrosion resistance of Nb-1% Zr, Nb-10% W-1% Zr (D-43 alloy), Ta-8% W-2% Hf (T-111 alloy), Mo-0.5% Ti-0.1% Zr (TZM), and Nb-10% W-10% Hf-0.1% Y (C-129 alloy) in boiling potassium environment at 1100 to 1400°C. No serious corrosion interactions were observed in 17 experiments involving over 67,000 hr of testing. Weight changes in insert specimens from the condenser section of the capsules were small and were related to migration of oxygen in the system. In addition, we exposed the alloy Nb-1% Zr to refluxing sodium, rubidium, and cesium at 1200°C and found no attack. Refluxing experiments in small-diameter capsules (<0.5 in.) indicated a boiling mechanism unlike that in larger capsules; accordingly capsule geometry is an important variable in comparing the results between various corrosion investigations. (auth)

14298 ELECTRICAL AND CORROSION PROPERTIES OF ALLOYS OF THE TITANIUM CORNER OF THE TITANIUM-VANADIUM-MOLYBDENUM SYSTEM. Elyutin, O. P.; Kalinin, G. Sb. Tr. Tsent. Nauch.-Issled. Inst. Chern. Met., No. 54, 71-6(1968). (In Russian).

A study was made of the electrical and corrosion properties of alloys containing V up to 60% or Mo up to 60% and Ti the remainder. The total contents of V and Mo were varied in steps of 10% with the ratio in the field of the ternary alloys 3:1, 1:1, and 1:3. Composition/electric resistance diagrams were constructed for alloys in the cast, annealed, and quenched conditions. The electric resistance, R, max. 1.45 $\mu\Omega$m, for the annealed state was shown by the 5% Mo + 16% V alloy. Quenching, which retained more completely the β solid solution, caused an increase in the maximum R up to 1.5 $\mu\Omega$m and shifted it towards alloys richer in Ti. Composition/corrosion-rate diagrams are given for corrosion tests in boiling 58% HNO_3, boiling H_2SO_4 solution, $CuSO_4$ solution, and in concentrated HCl at 20°C. (Referativnyi Zh.)

14299 PROTECTIVE CLADDING AND LUBRICANT FOR MECHANICALLY DEFORMABLE REACTIVE METALS. McDonald, R. E.; Reimann, G. A.; Patterson, F. H.; Leitten, C. F. Jr. (to United States Atomic Energy Commission). U. S. Patent 3,429,158. Feb. 25, 1969.

The hot-working or mechanical deformation of a reactive metal,

i.e., a metal normally oxidizable at an elevated temperature, is facilitated by providing the metal with a coating of molybdenum, tungsten, or certain of their alloys. These coating materials protect the underlying metal from oxidation and contamination and provide a lubricant for the mechanical deformation of the metal when the materials are oxidized. The oxides of molybdenum, tungsten, and their alloys are volatile above certain temperatures so as to provide a mechanically formed metal structure that is essentially free of surface oxides and virtually free of coating material. (AEC)

14300 ON THE MECHANISM OF STRESS-CORROSION CRACKING OF A TITANIUM-6 PERCENT ALUMINUM-4 PERCENT VANADIUM ALLOY IN ANHYDROUS METHANOL. Gegel, H. L.; Fujishiro, S. (Air Force Materials Lab., Wright-Patterson AFB, Ohio). J. Less-Common Metals, 17: 305-11(Mar. 1969).

Electron fractographic and high-resolution electron diffraction studies of the fracture surface of Ti-6Al-4V alloy specimens, tensile at 1.7×10^{-5} sec^{-1} in anhydrous methanol, respectively, revealed a hard, second phase on the fracture surface, TiH_2 associated with Ti_3Al. The crystallographic relationships of α, β, Ti_3Al, and TiH_2 were determined from the electron diffraction pattern, and they were in agreement with the expected relationships reported in the literature. The results support the conclusions made by Scully that stress-corrosion cracking in high-aluminum-containing titanium alloys is a form of hydrogen embrittlement. (auth)

14301 CORROSION AND COMPATIBILITY. Berry, W. E. DMIC Rev., 4p.(Sept. 13, 1968).

Corrosion studies on Al alloys are reviewed. Topics covering include pitting of ALMAG35 Al castings during H_2SO_4 anodizing; a temporary water-displacing corrosion preventive for use at damaged areas of paint films on Al aircraft; a new, accelerated stress corrosion test for Al alloys; and the effect of point defects and dislocations on the stress corrosion cracking susceptibility of 7075 Al alloy. Corrosion studies on Fe-base alloys, Ni- and Co-base alloys, Ti alloys and Ta alloys are also surveyed. (F.S.)

14302 THE ANTI-CORROSION PROPERTIES OF CORROSION-RESISTANT NICKEL-MOLYBDENUM ALLOYS. Svistunova, T. V. Sb. Tr. Tsent. Nauchn.-Issled. Inst. Chern. Met., No. 46, 50-7 (1966). (In Russian).

Results are given of a study of the influence of the carbide-forming elements V and Nb on the tendency of the Ni-Mo alloy N70M27 containing Mo 25 to 29 percent to intercrystalline corrosion in HCl and H_2SO_4 solution. The corrosion-resistance of the alloy is lowered by the presence of oxidizing agents in solution of these acids. The alloy EP 496(N70M27F), containing $C \leq 0.05$, $Si \leq 0.5$, $Mn \leq 0.5$, $S \leq 0.02$, $P \leq 0.025$, Mo 25 to 29, V 1.4 to 1.7, $Fe \leq 4$, $Cr \leq 0.3$, and $Ti \leq 0.3$ percent, is recommended for industrial use. (tr-auth)

14303 CORROSION AND ITS PREVENTION IN WATERS. Butler, G.; Ison, H. C. K. New York, Reinhold Publishing Corporation, 1966. 306p. $14.00.

The principles, phenomena, and the means of prevention and control of the corrosion problems arising from the contact of metals with water both natural and treated are presented. Corrosive action of water in industrial and manufacturing techniques is discussed. (J.C.W.)

Preparation and Fabrication

Refer also to abstracts 13932, 13963, 13965, 14391, 15671, and 15772.

14304 (BNWL-959) PREPARATION OF ^{147}Pm METAL AND DETERMINATION OF THE DENSITY AND MELTING POINT. Wheelwright, E. J. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan. 1969. Contract AT(45-1)-1830. 37p. Dep. CFSTI.

Four 30 g buttons of ^{147}Pm metal were prepared by Ca reduction of anhydrous $PmCl_3$. Additional purification was obtained by vacuum distillation of Ca and Mg impurities. The density of the metal was found to be 7.22 ± 0.03 g/cm^3 and the melting point, 1168 ± 6°C. Promethium metal was found to be highly reactive toward impurities in the protective argon atmosphere. The equipment used within the glove-box was designed for evacuation and backfill with protective argon, but rapid radiation damage or radiation-induced ozone damage of nonmetal tubing, gaskets and other sealants used in the equipment created continuous atmospheric containment problems. The Pm metal obtained in this work does not represent the optimum obtainable by the method. Promethium metal containing less than 200 ppM total impurities could reasonably be anticipated. (auth)

14305 (CEA-CONF-1051) INFLUENCE OF THE FOCUSING OF THE BEAM OF ELECTRONS ON THE FORM AND SIZE OF THE WELD MADE BY ELECTRONIC BOMBARDMENT. Boncoeur, M.; Marhic, J. Y.; Rapin, M. [1968]. 27p. (In French). (CONF-680540-1). Dep.

From 3rd International Conference on Electron and Ion Beams Science and Technology, Boston, Mass.

Experimental studies were made on the form and dimensions of welds produced by electronic bombardment in samples of stainless steel, uranium, aluminum alloy, copper, and graphite as a function of the distance separating the focusing point of the electron beam and the surface of the piece to be welded. It was established that the form, depth, size, regularity of the surface, and the depth of the weld varied. The variations were explained by findings that displacement of the electron beam focal point changed the specific strength and convergence of the beam on the surface of the piece to be welded as well as the penetration depth of the active beam into the sample and the metal fusion process. (tr-auth)

14306 IMPROVEMENTS IN OR RELATING TO THE CASTING OF METALS IN MULTIPLE MOULDS. (to Compagnie Pour l'Etude et la Realisation de Combustibles Atomiques). British Patent 1,136,843. Dec. 18, 1968. Priority date Mar. 15, 1965, France.

An apparatus and a method are described for casting metals such as uranium in a number of molds simultaneously with reduced metal loss. Excess metal is recovered in a form which can be easily prepared for reuse. The apparatus consists of a number of molds and a pan-shaped distributor for the molten metal. The distributor which is located above the molds has a number of orifices sized for the molds. A smaller orifice is located lower than other orifices and is associated with a larger auxiliary mold which is used to collect excess metal. (F.S.)

14307 PURIFICATION OF VANADIUM AND COLUMBIUM (NIOBIUM). Schmidt, F. A.; Carlson, O. N.; Krupp, W. E.; Wilhelm, H. A. (to United States Atomic Energy Commission). U. S. Patent 3,425,826. Feb. 4, 1969.

Vanadium or niobium which has been prepared by the aluminothermic reduction of the oxide is purified by heating at a temperature close to but below its melting point at a pressure of not more than 10^{-4} torr. The purified metal is then melted and cast in the absence of reactive gases. Carrying out the melting by an electron beam under high vacuum produces a further purification. (AEC)

14308 ECONOMICAL FABRICATION OF KING-SIZE STRUCTURES. Muser, C. J.; DeWitt, T. E. (North American Rockwell Corp., Los Angeles). Tool Mfg. Eng., 60: No. 5, 56-9(May 1968).

Successive diffusion bonding, hot forming, and welding methods are being used to fabricate Ti alloy skins for the 54-ft vacuum chamber of a zero-gradient synchrotron, one of the largest proton particle accelerators in the world, and the Ti Y-rings for the Saturn V booster rocket. Vacuum diffusion bonding is being used on the skins of the synchrotron; roll diffusion bonding is used for the Y-rings. Details of the various fabricating operations are given for both items. (L.C.L.)

14309 GENERAL SITUATION OF NEW METAL INDUSTRY IN JAPAN IN 1968. BERYLLIUM. Fujikawa, Tokio. Shin Kinzoku, No. 9, 49-51(Sept. 1968). (In Japanese).

Beryllium products of superior quality are produced in Japan, but the amount used is less than $\frac{1}{20}$ that of the U.S. Improvement of techniques, reduction of costs, expansion of demand, and countermeasures against capital liberalization are discussed. The beryllium ore economically used at present is beryl; its annual production in South America, South Africa, U. S., and Australia totaled 7000 tons. Beryl is very expensive because of supply shortage. The main product of beryllium is beryllium-copper alloy. Metallic beryllium is used in reactors and in aeronautical and space efforts, while beryllium oxide powder is used for the raw material of beryllium-copper alloy, and in electronics. The U.S. consumes 90% of the world production of beryl. The beryllium industry in the U.S. is described. (NSA of Japan)

14310 PACKING OF SOLID PARTICLES. Gray, W. A. Powder Technology Series. London, Chapman and Hall, 1968. 134p. 35s.

This book has an application to the manufacture of nuclear fuel elements. The subject is dealt with under the following headings: Characteristics of packing (closeness of packing, stability and strength of packings, permeability); approach to packing problems; particles (shape, absolute size, size distribution, properties of particle material); effects of container walls; deposition; compaction after deposition (vibration, pressure); industrial applications. (UK)

14311 SEPARATION OF METALS. Hardy, Clarence James; Field, Brian Orlando (to United Kingdom Atomic Energy Authority). U. S. Patent 3,419,348. Dec. 31, 1968. Priority date Apr. 22, 1963, Great Britain.

A process is described for the separation of certain metal compounds of a required metal from a mixture containing several metals or compounds. The process depends on formation of a volatile nitrate, nitrite, nitrato- or nitrosyl-compound of the required metal and separating it from non-volatile compounds of other metals by a distillation process. (Offic. Gaz.)

14312 GROWTH OF HEXAGONAL TITANIUM AND TITANIUM–ALUMINUM SINGLE CRYSTALS. Cass, T. R.; Quinn, R. W.; Spencer, W. R. (Martin Marietta Corp., Orlando, Fla.). J. Cryst. Growth, 2: 413-16(Dec. 1968).

Single crystals of titanium, α-phase titanium-aluminum can be grown directly from the melt if the $\beta \rightarrow \alpha$ transformation can be controlled. A growth technique using electron beam zone melting is described. The structure of the crystals is discussed. (auth)

14313 SUBMERGED ARC WELDING OF ASTM-A302GR.B HEAVY PLATE FOR ATOMIC REACTOR PRESSURE VESSEL. Okada, Kan; Murakami, Shiro (Yawata Welding Electrode Co., Ltd., Japan). Suiyokaishi, 16: 480-7(Oct. 1968). (In Japanese).

The development of submerged arc welding materials for ASTM A302B steel designed for reactor pressure vessels is described. Results indicate that the combination of the Mn–Ni–Mo wire, and fused-type high-basic flux gave a satisfactory welding result in preliminary tests carried out with 2 kinds of flux and 7 kinds of wire. The effects of inter-pass temperature and welding current on mechanical properties of weld metal was studied to establish the welding procedure. The combination of the Mn–Ni–No wire and high-basic flux was tested on A302B steel using 250 mm thickness specimens. The mechanical properties of weld metal after stress relief were established at more than 35.2 kg/mm^2 yield point, more than 56.2 kg/mm^2 tensile strength and more than 5.2 kg-m/cm^2 for 2 mm V-notch Charpy impact value at –12°C. It was also clear that this combination produced weld metal of especially homogeneous quality. (NSA of Japan)

14314 ON THE DEVELOPMENT OF ZIRCALOY CLADDING TUBES FOR NUCLEAR REACTORS. Nagai, Nobuyuki (Kobe Steel Works, Ltd., Japan). Kinzoku, No. 531, 49-53(Nov. 1968). (In Japanese).

Studies on the fabrication of Zr alloys and Zr cladding tubes were started in Japan about ten years ago. After improvements in the production technique and the tests, Zr-cladding tubes are produced and are used in research reactors. Mass-production plans are in progress, to meet demands in the future. Reactor-grade zirconium alloys, and the process of production of Zircaloy-clad tubes and their properties are described. The development of domestic production of Zircaloy-clad tubes is also described. (NSA of Japan)

14315 REFRACTORY METALS (Cb [Nb], Ta, Mo, W). Van Orsdel, J.; Maykuth, D. J.; Barth, V. D. DMIC Rev., 4p.(Oct. 4, 1968).

Recent research on the refractory metals includes work on the tensile, bend and stress rupture properties at up to 3000°F of T-222 Ta alloy sheets 0.029 to 0.034 in. thick; creep rupture properties in vacuum at 2200 to 3000°F, of Ta-10W, T-111 and T-222 Ta alloys; production and application of Ta-10W substrates clad with an oxidation-resistant Hg–Ta phase alloy; a new Ta-2.5W-0.15Nb alloy for chemical applications requiring superior corrosion resistance at 392°F; tensile properties and short time oxidation behavior in air at 2190 to 2550°F of ternary and more complex alloys in which Hf, W, and Ti are the major additions with small amounts of Zr, Al, Mo, Cr, Re, N_2, C and Y. Research also includes effects of trace elements such as Si, Al, and K on the sintering of W; comparisons of the mechanical properties of W-25% Re alloy sheet made by powder metallurgy or from arc melted billets; electron microscope study of the fracture in C-rich or O_2-rich cast W samples; tensile property measurements in W–Re alloys with up to 33% Re at 78 to 3630°F; oxidation resistance of W–Cr–Pd alloys when heated in air; fabrication of W-wire-reinforced composites by extrusion, and creep measurements in vacuum on Nb, Mo, Ta and W alloys at 1600 to 3200°F. 14 ref. (J.C.W.)

14316 ZIRCONIUM AND HAFNIUM INDUSTRY. Otsuka, Takeshi. Nippon Kogyo Kaishi, 84: 1034-9(July 1968). (In Japanese).

Zirconium raw material, $ZrSiO_4$, is produced in U. S. A., India, Ceylon, and Australia. At present, 200,000 tons are used yearly mainly in U. S. A. About 30,000 tons are used yearly for molding sand, fire bricks and the milky pigment for ceramics in Japan. In order to satisfy the requirements for nuclear characteristics such as corrosion resistance and workability, the purity of the metal is essential. The production of zirconium and hafnium, and their demand in the U. S. A., Europe, and Japan are described. (NSA of Japan)

14317 IMPROVEMENTS IN OR RELATING TO THE EXTRUSION OF COMPOSITE BODIES. Ormerod, Leslie Roy (to United Kingdom Atomic Energy Authority). British Patent 1,142,784. Feb. 12, 1969. Filed May 11, 1965.

Fuel element plates consisting of uranium–aluminum alloy sheathed externally with an aluminum cladding, suitable for use in water moderated reactors, can involve a difficult and expensive multistage rolling process. A simpler method is described of forming a sheathed fuel plate of the materials mentioned by the successive steps of forming a disc from the component materials, forming the disc into a sleeve member, interposing the sleeve between sleeves of sheathing material and co-extruding the assembly. The composite tube so formed is split lengthwise through the sheathing material to form an acurate plate. Preferably the disc is formed by a plurality of sector-shaped portions of fuel sheathing material and the portions joined by electron beam welding. (UK)

Properties Evaluations

Refer also to abstracts 13949, 14720, 14867, 14868, 14878, 15636, and 15738.

14318 (LA-DC-9809) ELECTROMETALLURGY OF PLUTONIUM. Leary, J. A.; Mullins, L. J. (Los Alamos Scientific Lab., N. Mex.). [1968]. 42p. (CONF-681204-1). Dep. CFSTI.

From Electrometallurgy and Electric Furnace Symposium, Cleveland, Ohio.

The chemistry, metallurgy, and electrometallurgy of plutonium has been complicated by its reactive nature and complex behavior. Process development from the early beginnings in 1944 to the present time are reviewed. Recent progress has resulted in a routinely operated plant that produces 99.98 percent pure plutonium on the 3.5 kg scale. Small scale procedures also have been developed for special applications such as producing the pure plutonium-238 that is required for the artificial heart radioisotopic power source. In addition to reporting procedures and results, the theory of electrorefining of plutonium is discussed. Electrowinning process developments and present status of this phase of electrometallurgy are reviewed. (auth)

14319 (RD/B/N-1229) ROLE OF BUBBLES IN FISSION GAS RELEASE FROM URANIUM DIOXIDE. Cornell, R. M.; Speight, M. V.; Masters, B. C. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Nov. 1968. 27p. Dep. CFSTI. UK.

Experimental evidence for the mechanisms of bubble mobility in irradiated UO_2 is reviewed. In the absence of an appreciable driving force, volume diffusion is the controlling mechanism, but surface diffusion is favoured in the presence of a large temperature gradient. Examination of the bubble distribution in irradiated material shows that significant directed bubble motion does not occur. This result is confirmed by theoretical analysis, and it is also predicted that Brownian movement is an unimportant mode of release for burn-ups of practical interest. A description is given of the theory of transport of gas to the grain boundaries involving the irradiation re-solution of intra- and intergranular bubbles. (auth) (UK)

14320 (TRG-Report-1459) SURFACE TENSION OF LIQUID SODIUM AND ITS WETTING BEHAVIOUR ON NICKEL AND STAINLESS STEELS. Todd, M. J.; Turner, S. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group). July 19, 1968. 33p. Dep. UK.

The surface tension and wetting characteristics of liquid sodium have been measured in a small pumped apparatus, in which the sodium could be continuously purified with respect to oxygen. Pure argon was used to blanket the free surface of sodium. The vertical plate (zero buoyancy) method of measuring the surface tension gave values in good agreement with recent published work. This method has the advantage that no precise knowledge of the sodium density is necessary. In experiments where the oxygen content of the sodium was changed, it was found that, over the temperature range 150 to 265°C, there were no significant differences between the surface tension of sodium containing nominally 5 ppM oxygen and sodium close to the solubility limit (10 to 80 ppM depending on the temperature). The wetting of nickel and stainless steel was found to depend a great deal on the cleaning process employed, as well as on the sodium temperature. Contamination of the sodium with oxygen accelerated the wetting of

nickel but retarded that of the stainless steels. Possible reasons for this behavior are discussed and additional evidence is given, in the case of stainless steels, from rubbing experiments in liquid sodium. (auth)

14321 (UCRL–18639) HIGH TEMPERATURE DEFORMATION OF A MOLYBDENUM ALLOY STEEL. Amin, Kamal Elsayed (California Univ., Berkeley. Lawrence Radiation Lab.). Dec. 1968. Contract W-7405-eng-48. 28p. Dep. CFSTI.

Thesis.

The creep behavior of a 4 wt % Mo spheroidized steel from 875 to 1075°K, obeys the empirical relation: $(\dot{\gamma}_s kT/DGbe^{-Hc/RT}) = A(\tau/G)^{6.8}$ where A is a constant independent of temperature, τ is the applied shear stress, G is the shear modulus, D is the self diffusivity of α-Fe, H_c is a constant independent of temperature and stress and is equal to 13 kcal/mole, k is the Boltzmann's constant, R is the gas constant and T is the absolute temperature. Creep of this alloy was compared with that for α-Fe. A dislocation climb controlling mechanism is postulated. (auth)

14322 (WAPD-TM–787) EFFECTS OF ELECTRICAL DISCHARGE AND ELECTROCHEMICAL MACHINING ON THE FATIGUE STRENGTH OF SELECTED STRUCTURAL MATERIALS. McGowan, E. J.; Faber, J. W. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Jan. 1969. Contract N5015. 27p. Dep. CFSTI.

The results of constant axial deflection fatigue tests on specimens of structural materials machined by electric discharge and electrochemical processes are reported. It is shown that average fatigue strength reduction factors as large as 2.77 are obtained if the effects of intentional arc strikes are included. (auth)

14323 TENSILE BEHAVIOR OF POLYCRYSTALLINE YTTRIUM FROM 77 TO 773 K. Koepke, B. G.; Gibson, E. D.; Scott, T. E. (Ames Lab., Iowa). Contract W-7405-eng-82. Amer. Soc. Metals, Trans. Quart., 60: 409-17(Sept. 1967). (IS–1568).

Mechanical properties of polycrystalline yttrium of two different grain sizes were determined at 77 to 773°K. Temperature-change and strain-rate-change tests were run in order to evaluate the temperature dependence, strain-rate sensitivity, and the activation volume associated with deformation. The activation volume was approximately $10b^3$ at low temperature by the expression $-\sigma(\epsilon) = \sigma_\beta \exp(-1.06 \times 10^{-3}T)$. Indications of strain aging were observed and the perturbing effect of this phenomenon on the deformation characteristics was discussed. (auth)

14324 PRECIPITATION AND RECRYSTALLIZATION IN AN Al–0.5 WT PERCENT Zr ALLOY. Ryum, N. (Central Inst. for Industrial Research, Oslo). Acta Met., 17: 269-78(Mar. 1969).

The precipitation in an Al–½ wt. % Zr-alloy and the influence of the precipitated particles on the plastic deformation and recrystallization have been studied by means of micro-hardness measurements, quantitative metallography and thin foil technique. The supersaturated solid solution was obtained after rapid solidification and subsequent cooling to room temperature. The precipitation occurs via an intermediate cubic phase to the equilibrium tetragonal Al_3Zr. The precipitates are mostly rodshaped, arranged in a fanshaped fashion which is thought to delineate the segregated regions obtained during solidifications. The rods are surrounded by strain-fields which generate characteristic contrast phenomenon. The great stability of the particles is attributed to low solubility and low interfacial energy of the particles. It is found by qualitative metallography that the particles raise the recrystallization temperature of aluminum considerably. The reason for this is shown to be twofold: the particles lead to a more uniform distribution of dislocations during deformation, and have also a pinning effect on grain- and subgrain-boundaries during annealing. (auth)

14325 THE X-RAY DEBYE TEMPERATURES OF TELLURIUM AND CADMIUM. Walford, L. K.; Carron, Gene J.; Schoeffel, James A. (McDonnell Douglas Corp., St. Louis). Mater. Res. Bull., 3: 911-18(Nov. 1968).

The Debye temperatures of tellurium and cadmium have been determined to be 139 ± 6°K and 134 ± 4°K respectively by measurement of the x-ray integrated intensity of Bragg reflections from powder specimens in the temperature range 77 to 293°K. A thermal diffuse scattering correction was made. No significant anisotropic effects could be detected even though tellurium and cadmium have non-cubic unit cells. (auth)

14326 TENSILE DEFORMATION OF COPPER SINGLE CRYSTALS CONTAINING BeO PARTICLES. Jones, R. L. (Franklin Inst. Research Labs., Philadelphia). Acta Met., 17: 229-35(Mar. 1969).

Data from tensile tests at three temperatures on copper single crystals strengthened by fine dispersions of BeO particles, produced by internal oxidation, are discussed with reference to recent developments in the theories of dispersed particle strengthening. The yield stresses of the crystals, which are orientation dependent, correlate quite well with the yield mechanism suggested by Orowan and recently discussed in detail by Ashby. Marked anelastic and microplastic behavior at stresses below the general yield stress is shown to be qualitatively consistent with the details of the Orowan mechanism of yielding. Increments of shear stress at a shear strain of about 0.1 are only found to agree with the predictions of the strain hardening theory of Ashby for crystals tested at 77°K. Crystals tested at higher temperatures show markedly reduced rates of strain hardening, due to the occurrence of recovery during the tests. (auth)

14327 THERMAL EXPANSION OF INDIUM–THALLIUM ALLOYS IN THE VICINITY OF THE F.C.C.–F.C.T. TRANSITION. Pahlman, J. E.; Smith, J. F. (Ames Lab., Iowa). J. Less-Common Metals, 16: 397-405(1968).

An interferometric technique was used to determine the expansion behavior of indium–thallium alloys at 4.2 to 360°K and in the composition range 19 to 35 at. % thallium. Extensive data were accumulated for four single crystals in this region, and supplementary data from five polycrystalline specimens were taken. The data indicate the existence of a narrow two-phase region, <0.5 at. % in width, between the fcc and fct phase fields which is consistent with the fcc ⇌ fct transformation being first order. Two temperature regions of anomalous expansion were found for the fcc phase: one in the region 70 to 100°K and one in the region 210 to 230°K. These anomalies consist of inflections in the dimensional change as a function of temperature and reflect, respectively, maxima and minima in plots of the thermal coefficients of expansion vs. temperature. (auth)

14328 ON THE RELATION OF THE TERMINAL SOLUBILITY OF HYDROGEN TO THE DUCTILITY DROP IN VANADIUM. Owen, C. V.; Sherman, D. H.; Scott, T. E. (Ames Lab., Iowa). Trans. Met. Soc. AIME, 239: 1666-7(Oct. 1967). (IS–1590).

Results of visual observations of the brittle transition behavior of V with increased H content are presented. Accurately defined ductile-brittle transition is compared with the apparent transformation temperature. Curves are included that show the low temperature terminal solubility of H in V and the temperature dependency of V containing 53 ppM of H. Ductility in terms of elongation drops sharply and is well defined over a temperature range of ~15°K. Area reduction drops in the same region but less abruptly. (F.S.)

14329 GALVOMAGNETIC EFFECT AND ELASTO-RESISTANCE OF IRON–[78 PERCENT] NICKEL ALLOY CONTAINING OTHER ADDITION ELEMENTS. Popova, V. P. Sb. Tr. Tsent. Nauch.-Issled. Inst. Chern. Met., No. 54, 55-60(1968). (In Russian).

The galvomagnetic effect (I) and the elastroresistance (II) were determined for specimens of Fe–78% Ni containing Nb, W, Re, Ta, or Mn. The specimens were either vacuum annealed at 1100°C for 3 hr, cooled to 600°C at 100°C/hr, steady cooled from 600 to 200°C over 6 days and air cooled from 200°C; or annealed in a vacuum ampul at 1100°C for 3 hr and then quenched (with the ampul) in cold water. The limiting values of (I) and (II) decreased with increasing contents of the alloying elements. The alloys containing Ta showed equal limiting values of (I) and (II). The limiting value of (I) was greater than that of (II) in alloys containing Re, W, Mn, and Nb. There was little change in (I) for sudden changes in elastic stress. The saturation magnetorestriction in Fe–Ni–Re alloys decreased with increasing Re content; in the 4.5% Re region it changed sign from positive to negative. (Referativnyi Zh.)

14330 RELAXATION EFFECT DUE TO THE STRESS-INDUCED DIFFUSION OF INTERSTITIAL OXYGEN IN TANTALUM. Cannelli, G.; Verdini, L. (Istituto Nazionale di Ultracustica, Rome). Nuovo Cim., 59B: 19-32(Jan. 11, 1969).

The diffusion coefficient of interstitial oxygen atoms in tantalum has been determined by measurements of the elastic energy dissipation as a function of the temperature. The relaxation peak related to this process was found with its maximum at 346°C for a vibration frequency of about 20 kHz. The analysis of the experimental data gives an activation energy W = 1.19 eV and a diffusion constant $D_0 = 1.9 \cdot 10^{-2}$ cm²/s, in very good agreement with some previous results obtained at very low frequencies. A description of the new features of the experimental technique is also given. (auth)

14331 ELASTIC ANISOTROPY AND ITS TEMPERATURE VARIATION OF SINGLE CRYSTALS OF THE HIGH ELASTICITY ALLOY "DIA-FLEX" IN THE Co–Fe–Ni–Cr–W–Mo SYSTEM. Masumoto, Hakaru; Saito, Hideo; Kikuchi, Michio (Research Inst. of Electric and Magnetic Alloys, Sendai). Trans. Jap. Inst. Metals, 9: 257-62(Oct. 1968).

Temperature dependences of thermal expansion, Young's modulus and rigidity modulus, and mechanical strength at room temperature were measured with single crystals and annealed polycrystals of high-elasticity alloy Dia-flex with the fcc structure. Dia-flex, composed mainly of 38.0% Co, 22.4% Fe, 16.5% Ni, 12.0% Cr, 4.0% W and 4.0% Mo showed the Young's modulus of 23×10^3 kg/cm^2, the elastic limit of 120 kg/mm^2 and tensile strength of 250 kg/mm^2 in the rolling direction. From the data obtained, the volume compressibility, principal elastic parameters, principal elastic constants, and Young's modulus and rigidity modulus in the three principal orientations of the single crystals were calculated. The results thus obtained are as follows: the Young's moduli at 20°C are 11.68×10^5 kg/cm^2, 22.49×10^5 kg/cm^2 and 33.78×10^5 kg/cm^2, and the rigidity moduli at 20°C, 12.01×10^5 kg/cm^2, 6.02×10^5 kg/cm^2 and 5.13×10^5 kg/cm^2 in the ⟨100⟩, ⟨110⟩ and ⟨111⟩ directions of the single crystals, showing a high anisotropy, of the elastic moduli. The anisotropy of the temperature coefficients of elastic moduli is also very high. (auth)

14332 A CONTINUOUS COMPILATION OF NEW REFERENCE DATA ON DIFFUSION PROCESSES IN INORGANIC SOLIDS AND THEIR MELTS. VOLUME 2, NO. 3/4, DECEMBER 1968. Diffus. Data, 2: 246-451(Dec. 1968).

Data are included on temperature and pressure ranges applicable to new findings along with information on experimental methods employed for data determinations and purity and properties of the materials used. Definitions for diffusion coefficient, isotope effect, thermal diffusion or thermotransport, electrotransport or electrolytic diffusion, and the permeation of gases are given. A listing of 299 references is given. (J.C.W.)

14333 TENSILE DUCTILITY OF RHENIUM AT 1200°C. Servi, I. S. (Kennecott Copper Corp., Lexington, Mass.). J. Less-Common Metals, 17: 340-3(Mar. 1969).

Studies were made on the cause of low hot-ductility of rhenium. It was concluded that rhenium is inherently ductile at 1200°C, that low hot-ductility may be observed even when the oxygen contents of the material and of the atmosphere are low, and the removal of low-melting elements by zone refining is the probable cause of a marked increase in hot-ductility. (M.C.G.)

14334 DIFFUSION OF ^{51}Cr INTO POLYCRYSTALLINE NIOBIUM. Pelleg, Joshua (National Research Council of Canada, Ottawa). J. Less-Common Metals, 17: 319-24(Mar. 1969).

High-purity chromium, which was pile-irradiated to produce ^{51}Cr, was deposited on niobium specimens by vacuum evaporation to a thickness estimated to be 100 to 300 Å. The diffusion species were wrapped in niobium foil and annealed. Sections of the specimens were taken by anodizing and stripping. The gamma activity of each section was measured over the 0.325-MeV peak. Data are given in tables and graphs. (M.C.G.)

14335 CRITICAL REVIEW OF THE PEIERLS MECHANISM. Guyot, Pierre; Dorn, John E. (Univ. of California, Berkeley). Can. J. Phys., 45: 983-1016(1967). (UCRL-16992).

A thorough review is made of the application of the Peierls model to the macroscopic plastic deformation of ionic crystals, metals, alloys, and covalently bonded crystals. The effects of the shape of the Peierls hill, kink–kink energies, and the frequency terms on the stress–temperature and activation volume–stress relationships are extended and discussed. Theory is compared with experimental results, giving special emphasis to recent advances. Single-crystal data for $\frac{1}{2}\{111\}\{110\}$ thermally activated slip in Ta and Mo at low temperatures agree well with the dictates of the Peierls mechanism. Deformation characteristics of polycrystalline Fe alloys containing either 2 wt % Mn or 11 at. % Mo agree with expectations based on the Peierls mechanism only at temperatures below about 200°K. At higher temperatures, the effective stress decreases more slowly and the activation volume increases more rapidly with increasing temperature that can be accounted for by the Peierls mechanism. Over this higher temperature range, however, the experimental data are in good agreement with Escaig's mechanism based on the recombination of dissociated screw dislocations. It is also shown that low-temperature $\frac{1}{2}\{111\}\{123\}$ slip in AgMg, prismatic slip in Ag plus 33 at. % Al, and in Mg plus 6 to 12 at. % Li occurs by the Peierls mechanism. (auth)

14336 FERROMAGNETIC BEHAVIOR OF IRON ALLOYS CONTAINING MOLYBDENUM, MANGANESE, AND TANTALUM. Arajs, S. (Clarkson Coll. of Tech., Potsdam, N. Y.). Phys. Status Solidi, 31: 217-22(Jan. 1, 1969).

The mass magnetization of iron-rich binary iron solid solutions, containing molybdenum, manganese, and tantalum, have been studied as a function of the internal magnetic field at 298°K. The mass spontaneous magnetizations have been determined from these data using the Belov–Arrott–Kouvel method. The values of the spontaneous magnetization as a function of molybdenum or manganese concentration are in fair agreement with previous investigations of the saturation magnetization by Aldred and Sadron, respectively. The spontaneous magnetizations for iron–tantalum alloys have been measured for the first time. These investigations indicate that, from the viewpoint of the bulk magnetization, molybdenum, manganese, and tantalum very approximately produce a simple dilution effect. (auth)

14337 CALCULATION OF THE INFLUENCE OF BOUND DIVACANCIES ON THE ISOTOPE EFFECT FOR SELF-DIFFUSION IN F.C.C. METALS. Bakker, H. (Univ., Amsterdam). Phys. Status Solidi, 31: 271-5(Jan. 1, 1969).

With the aid of Howard's theory for computing the correlation factor for self-diffusion by divacancies on the isotope effect for self-diffusion in fcc metals is calculated. It turns out that a divacancy contribution lowers the isotope effect. This result is compared with experimental values for palladium and silver, and with the usual interpretation of small isotope effects following Vineyard's theory. (auth)

14338 THERMAL PROPERTIES OF A LAYER OF "SULFINUZ" ON STAINLESS STEEL NEAR THE OPERATING CONDITIONS OF A NUCLEAR REACTOR OF THE GRAPHITE–GAS TYPE. Mazaud, J. C.; Morlevat, J. P. (Laboratoire de Metallurgie, Alcatel, France). Rev. Met. (Paris), 65: 285-93 (Apr. 1968). (In French).

The "Sulfinuz" procedure produces a hard surface layer of sulfides and carbo-nitrides of Fe, reducing the risk of seizing by friction between pieces in stainless steel; studies of the steel at 500°C and diffusion of constituents of the layer are reported. The decrease in stretching at rupture at room temperature after sulfinuzation is 6% to 8%. At 500°C under 26 bar CO_2, penetration of the surface layer is noted, particularly for C, whose energy of activation for penetration at this temperature is 17,100 ± 2,100 cal/g-atom. Penetration of C is accelerated by N; penetration of S is intergranular. The hardness peak under these conditions corresponds to maximum N content in the layer, so that the penetration of the layer of maximum hardness is very slow. A technique for cleaning the surface before welding sulfinuz steel is described and uses HF and HNO_3. Application of these data to use in nuclear reactors is noted. (BBB)

14339 SOME DEVELOPMENTS IN ZIRCALOY BRAZING TECHNOLOGY. Amato, I.; Ravizza, M. (FIAT, Turin). Energ. Nucl. (Milan), 16: No. 2, 35-9(Feb. 1969).

The influence of temperature and soaking time on the properties of the Be–Zr alloy braze bond between Zircaloy strips was determined. The best brazing cycle is 10 min at 1010°C followed by 4 to 6 hr at 800°C. The brazed joints have a strenth of 85 to 90% of the base material. Corrosion resistance behavior of the brazed Zircaloy is no worse than the base material and the H content of the brazed specimens exposed to water at 340°C does not increase. The mechanical properties variation of annealed material submitted to the brazing heat treatment is small. Local high Be concentration on the bond was obtained after the heat treatment. (F.S.)

14340 AGING AND MECHANICAL PROPERTIES OF IRON–13 AT. PERCENT BERYLLIUM ALLOY. Yamagata, Toshihiro; Yagizawa, Kohei. Tetsu To Hagane, 54: 386-8(Aug. 1968). (In Japanese).

The changes in mechanical properties of Be-base alloys due to aging were investigated, using Fe–13 at % Be. The samples were prepared and aged at 300, 500, 600, and 700°C, by heating in a salt bath when the heating time was shorter than 20 hours, and by sealing them in vacuum in quartz tubes and heating them in a furnace when the heating time was longer than 20 hours. Compression tests were carried out on the samples with the strain rate of 2.5×10^{-4}/sec and observations using a 100 kV electron microscope were made on thin foils. The data on 0.2% flow stresses were plotted against the aging time, producing age hardening curves classified in two groups, one of them corresponded to 300 and 700°C aging with value of about 50 kg/mm^2, and the other corresponded to 500 and 600°C aging with higher values of 120 ~ 150 kg/mm^2. The latter group was dominated by the slip deformation and corresponded to the condition in which the intermediate phase precipitated over the surface. During the time in which the flow stress was reduced at 600°C, coarsening of the intermediate phase was observed. The former group was dominated by the twin deformation similar to the quenched condition, but the amount of stress decline due to the twin formation and the amount of the mixed slip deformation underwent changes by aging. (NSA of Japan)

14341 BRITTLE FRACTURE PREVENTION IN THICK PLATES FOR NUCLEAR REACTORS. Ogura, Nobukazu; Okuma, Isamu. Koatsuryoku, 6: 1347-53(July 1968). (In Japanese).

Brittle fracture tests of thick steel plates for nuclear reactors were carried out on A302B, A212B, A543-1 and A533-1 steels, using test pieces with a press notch for crack propagation. On A302B steel, the characteristic of brittle crack occurrence was also investigated by tensile testing wide plates with a notched longitudinal joint and tensile testing wide plates with various welding defects. A543-1 steel showed good characteristics in prevention of brittle cracks in comparison with the other kinds of steels. In determining the NDT temperature from the results of Charpy V notch test, it is necessary to pay attention to results indicating dangerous conditions. There was no contradiction between the NDT temperature and the evaluation of safety by the propagation test with large test pieces. The arranging method with Kc values and the coefficient for the plate thickness effect were applicable for those propagation test results of temperature gradient type on very thick steel plates and on thinner steel plates. (NSA of Japan)

14342 TECHNIQUE FOR ANNEALING IRRADIATED URANIUM UNDER HIGH HYDROSTATIC PRESSURES AND TEMPERATURES. Kulcinski, G. L.; Thiede, R. A.; Hann, C. R. (Battelle Memorial Inst., Richland, Wash.). Contract AT(45-1)-1830. Rev. Sci. Instrum., 40: 214-17(Feb. 1969).

The equipment, techniques, and philosophy associated with experiments designed to anneal irradiated uranium in NaK to temperatures as high as 900°C and pressures as high as 1000 bars are described. Considerable attention is paid to the details of the experimental procedure owing to the inherent dangers connected with such tests. (auth)

14343 NON-FERROUS EXTRACTIVE METALLURGY IN THE UNITED KINGDOM. Ryan, W. (ed.). London, Inst. Mining and Metallurgy, 1968. 248p. 88s.

Summaries of information on the extractive metallurgy of the following metals of interest in the nuclear industries are given: Al, Be, B, ferro alloys, Ge, Li, Mg, Mo, Nb, rare earths, Th, W, U, V, Zr, etc. (UK)

14344 THE ANISOTROPY OF THE CRITICAL CURRENT DENSITY OF SUPERCONDUCTING OXYGEN-DOPED NIOBIUM (COLUMBIUM). Jones, K. A.; Rose, R. M. (Massachusetts Inst. of Tech., Cambridge). Trans. Met. Soc. AIME, 245: 67-73(Jan. 1969).

Resistive measurements were made on superconducting niobium single crystals in transverse magnetic fields. Crystals were grown in both high and ultrahigh vacuums, doped with small quantities of oxygen, and annealed in ultrahigh vacuums at 900 to 1350°C. Maximums in the fluxoid pinning force were observed for the [100] and [210] directions. The increase of the critical current density with dissolved oxygen was seen to saturate at relatively low concentrations. This behavior, and the variation of J_c and residual resistivity (as a function of oxygen content and annealing) of both clean and dirty (gassy) crystals, is seen as a consequence of the formation of clusters with $(210)_{Nb}$ habit planes and $(100)_{Nb}$ common boundaries. These suboxide clusters are apparently stable at high temperatures and very low oxygen concentrations. (auth)

14345 PARTIAL EXCESS ENTROPIES OF HYDROGEN IN METALS. Gallagher, P. T.; Oates, W. A. (Univ. of Newcastle, New South Wales, Australia). Trans. Met. Soc. AIME, 245: 179-82(Jan. 1969).

An analysis leading to correlation between the partial excess entropy of interstitial solutes in metals and the relative enthalpies and excess entropies of hydrogen per g-atom of H (standard state H_2 at 1 atm) is presented. The correlation between relative partial heat of solution and relative partial excess entropies of H in bcc, hcp, and fcc metals is illustrated. (J.R.D.)

14346 CONDUCTIVITY OF ULTRATHIN FILMS OBTAINED BY VAPORIZING TANTALUM IN A VACUUM. Layner, D. I.; Kholmyanskii, V. A. Izv. Akad. Nauk SSR, Neorg. Mater., 3: 1673-5(1967). (In Russian).

The conductivity of ultrathin films deposited on quartz by vaporizing Ta in a high vacuum (5×10^{-6} mm) was studied as a function of annealing temperature. The films were subjected to successive anneals at 250, 450, and 650°C. All the temperature dependences of the resistance of the films studied had an exponential character and were expressed by the formula $R = C \exp(Q/2kT)$. The variation of the resistance for films 7.2 ± 0.2 Å thick deposited at various substrate temperatures is shown. Adsorption on the film surface decreases the activation energy. The anneals cause an irreversible change in activation energy and in the preexponential coefficient. An irreversible change of structure occurs as a result of surface migration during annealing, when the atoms occupy energetically most favorable positions. Surface migration changes the shape and size of the granules, their number, and also affects the composition of intergranular layers. (ATD)

14347 RESISTOMETRIC STUDY OF HYDRIDE PRECIPITATION IN ZIRCALOY-2. Sasaki, Yasuo; Kimura, Hirozo (National Research Inst. for Metals, Tokyo). Suiyokaishi, 16: 462-5(Oct. 1968). (In Japanese).

The kinetics of hydride precipitation in Zircaloy-2 was investigated by a resistometric method during aging. Two stages were found in the process of the hydride precipitation. In the first stage, the time exponent of 1 was obtained and it was considered that the precipitates grew in the form of plates whose dimensions were small, in comparison with their separations. The second stage having the time exponent of 1/2 was interpreted in the thickening of plates of hydride grown in the first stage. The activation energy determined from the isothermal data was about 8,000 cal/mol in both stages. This value was in agreement with that for the diffusion of hydrogen in α-zirconium. (NSA of Japan)

14348 EFFECTS OF PLANISHING AND THERMAL TREATMENTS ON WELDED Ti-6Al-4V ALLOY. Albertin, L. (Boeing Co., Kent, Wash.). Weld. J. (N. Y.), 48: 34s-44(Jan. 1969).

Room temperature roll planishing tests were carried out on 0.125-in. thick Ti-6Al-4V weldments to study the effect of various roll planishing pressures on the residual stress, tensile, formability, and fracture toughness properties. In addition, thermal treatments were applied to as-welded 0.375-in. thick Ti-6Al-4V weldments to evaluate changes in mechanical properties. Roll planishing substantially decreased uniform elongation. Planished weldments were less formable than weldments not planished. Tempering weldments at 1500°F for 1 hr followed by a water quench increased uniform elongation by approximately 90% over the as-welded condition and reduced the yield stress-ultimate stress ratio from 0.88 to 0.76; when both the base metal and weld metal were given this thermal treatment, similar mechanical properties were obtained in the two materials. The effect of roll planishing on fracture toughness was studied by means of precracked Charpy impact tests and shallow crack tensile specimens. Average data for both toughness evaluations indicated that roll planishing adversely affected the precracked Charpy impact toughness, while the fracture toughness parameter K_{IC} was not affected. Stress relieving weldments at 1200°F for 2 hr decreased the impact toughness. Highest impact toughness was obtained in as-welded specimens tempered at 1500°F for 1 hr, followed by a water quench. Maximum tensile properties in Ti-6Al-4V welds were obtained by a beta treatment followed by solution treating and aging. (auth)

14349 ELECTROCHEMISTRY OF MOLTEN SALTS AND SOLID ELECTROLYTES. MECHANISM AND KINETICS OF ELECTRODE PROCESSES. Pal'guev, S. F. (Academy of Sciences, Sverdlovsk, USSR). Tr. Inst. Elektrokhim., Akad. Nauk SSSR, Ural. Filial, No. 11, 3-136(1968). (In Russian).

Fourteen articles are included on the studies of electrode processes in solid and gaseous electrodes in galvanic elements with molten salt electrolytes. The theory of diffusion potential and current micro distribution on a cathode of salt melts and kinetics of anode and cathode processes during zirconium, tungsten, hafnium and niobium electrolysis are discussed. Copper and tungsten electric crystallization and preparation of diffusion coatings of boron, silicon, and cobalt are described as well as corrosion in carbonate melts. (tr-auth)

14350 THE EFFECTS OF Ce, Y, Al, AND Zr ON THE PROPERTIES OF 25Cr-20Ni STAINLESS CAST STEEL. Kuki, Hidekatsu; Kokonoe, Tsuneo. Tetsu To Hagane, 54: No. 10, 314(Aug. 1968). (In Japanese).

The effects of very small amounts of Ce, Y, Al, and Zr on the properties of 25 Cr-20 Ni steel were investigated. On the as-cast samples, the mechanical properties at room temperature and high temperature, the oxidation resistance, and the carburization resistance were studied. On the samples aged at 950°C for 100 hours, the mechanical properties at room temperature and high temperature were studied. Crystal grains of the cast were made finer by Ce, Y, and Zr, and remarkably coarser by Al. Data on the mechanical properties are shown for tests at room temperature and 900°C. The material without the addition of alloy elements was the strongest. At 900°C, the strengths of the materials were almost the same except for the material with the Al addition. The strength at high temperature of the material aged at 950°C declined in comparison with the strength of the as-cast material. The as-cast material with Al addition showed the highest Charpy impact value but aging at 950°C produced the same effect. Impact values declined upon aging the materials with Al addition. The material with Y addition showed no change in the impact value due to the fact that Y was in the form of an oxide. (NSA of Japan)

14351 PROPERTIES AND TRANSFORMATION CHARACTERISTICS OF WELDS IN Ti-6Al-2Sn-4Zr-2Mo TITANIUM ALLOY. Mitchell, D. R. (Titanium Metals Corp. of America, West Cald-

well, N. J.); Tucker, T. J. Weld. J. (N. Y.), 48: 23s-33(Jan. 1969).

The results from an extensive investigation of weld mechanical properties of Ti–6Al–2Sn–4Zr–2Mo alloy are presented. Included are room and elevated temperature tensile test results, creep and thermal stability test results, notched tensile properties of arc welds, and the strengths of resistance welds. The effects of various preweld- and postweld heat treatments are included as well as recommended procedures. A second phase concerns the transformation characteristics of the alloy. Continuous-cooling-transformation (CCT) diagrams were constructed. Details of the experimental procedure are included. The results demonstrated that, with some variation, the Ti–6Al–2Sn–4Zr–2Mo alloy starts to transform relatively fast upon cooling and completes its transformation quite rapidly. Variations just mentioned are, for the most part, caused by factors relating to cooling rate (heat input, chill fixtures, and material gage). It is shown that a typical weld in sheet material cools within a range of rates which produce nonequilibrium transformation. (auth)

14352 THE STUDY ON THE STEELS FOR PRESSURE VESSEL OF NUCLEAR REACTOR. III. THE EFFECT OF THERMAL CYCLES ON A302B STEEL. Hasegawa, Masayoshi; Sano, Masayuki (Waseda Univ., Tokyo). Tetsu To Hagane, 54: No. 10, 211(Aug. 1968). (In Japanese).

The metallic changes in specimens caused by thermal cycles, and the low cycle fatigue caused by thermal stresses, were studied in an apparatus which repeated comparatively slow heating and cooling so as not to apply mechanical restraint was used to measure the plastic deformation due to thermal cycling. The test samples were A302B steel, 18-8 stainless steel, and carbon steels. The conditions of thermal cycle were 100 ⇌ 400°C, 400 ⇌ 700°C, and 100 ⇌ 900°C. The elongation resulting from thermal cycling did not change in the thermal cycles at 100 ⇌ 400°C, and increased with the increasing number of cycles at 400 ⇌ 700°C and 100 ⇌ 900°C. Hardness showed a peak at 10 ~ 30 cycles, and diminished with continued cycling. The tensile strength declined and the ratio of the yield stress to the tensile strength showed a rising trend with thermal cycling. The cohesion of carbide proceeded at 200 cycles in the 100 ⇌ 400°C cycle and at 100 cycles in the 400 ⇌ 700°C cycle. In the 100 ⇌ 900°C cycle, the amount of the initially precipitated ferrite increased with increasing number of cycles. Coarsening of the carbide grains was observed. It was found that the mechanical properties changed with change of metallic structure, even when a change in elongation was not evident. (NSA of Japan)

14353 INTERDIFFUSION STUDIES IN URANIUM–SILICON SYSTEMS. Lebedev, S. Ya.; Taurbaev, T. I.; Pavlinov, L. V. At. Energ. (USSR), 26: 73-4(Jan. 1969). (In Russian).

Interdiffusion in uranium–silicon system was studied in order to obtain data on the structure and rate of silicide phase formation on the surface of metallic uranium in contact with silicon. Specimens of 99.72% pure uranium and 1 to 2 mm thick specimens of monocrystalline silicon were subjected to thermodiffusion annealing in a ring under 90 kg/cm² pressure at 700°C. Data obtained showed a diffusion zone consisting of a single-phase layer of USi_2. The temperature dependence of the silicide plate growth is presented in the graph lg P = f(1/T) where $p = 2.3 \times 10^7 \exp(-73200/RT)$ cm²/sec. For the USi_2 plate, the magnitude of specific resistance is $p = 1.8 \times 10^4$ ohm cm. The USi_2 have a hole type conductivity independent on the conductivity of the initial silicon plates. (R.V.J.)

Structure and Phase Studies

Refer also to abstracts 14312, 14327, and 14893.

14354 (AECL-2761) METALLURGICAL STRUCTURES IN A HIGH URANIUM–SILICON ALLOY. Wyatt, B. S.; Berthiaume, L. C.; Conversi, J. L. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Oct. 1968. 37p. Dep. CFSTI. CAN $1.00.

The effects of fabrication and heat treatment variables on the structure of a uranium–3.96 wt % silicon alloy have been studied using optical microscopy, quantitative metallography and hardness determinations. It has been shown that an optimum temperature exists below the peritectoid temperature where the maximum amount of transformation to U_3Si occurs in a given period of time. The time required to fully transform an as-cast alloy at this optimum temperature is affected by the size of the primary U_3Si_2 dendrites. With a U_3Si_2 particle size of <12 μm complete transformation can be achieved in four hours. (auth)

14355 (NLCO-1022) MICROSTRUCTURES OF AS-CAST URANIUM-BASE DILUTE ALLOYS. Wexlin, L. G.; Schaich, E. L. (National Lead Co. of Ohio, Cincinnati). Feb. 1969. Contract AT(30-1)-1156. 37p. Dep. CFSTI.

Microstructures of 98 as-cast uranium-base dilute alloys were examined. The alloys were binary, ternary, quaternary, and quinary combinations of carbon, iron, aluminum, and silicon (1000 ppM or less of each) in uranium. (auth)

14356 REFINEMENT OF A Th_2Zn_{17} STRUCTURE: Pr_2Fe_{17}. Johnson, Quintin (Univ. of California, Livermore); Wood, David H.; Smith, Gordon S.; Ray, A. E. Contract W-7405-eng-48. Acta Crystallogr., Sect. B, 24: 274-6(Feb. 1968). (UCRL-70458).

The phase, previously called $PrFe_7$, has been reinvestigated by single-crystal x-ray diffraction methods using data obtained with a diffractometer and molybdenum radiation. As reported earlier, the compound is rhombohedral, space group $R\bar{3}m$, with a = 8.585, c = 12.464 Å; contrary to earlier findings, it has the composition Pr_2Fe_{17} and an ordered Th_2Zn_{17}-type structure. Ce, Nd, and Sm in combination with Fe have all been reported previously to form the same structure as the Pr–Fe compound. The composition AB_7 reported for these three phases is therefore in doubt. For AB_x compounds of the $ThZn_{8.5}$ (Th_2Zn_{17}) type, no conclusive crystallographic evidence has yet been put forth for x other than 8.5. (auth)

14357 A STUDY OF SOME PALLADIUM–INDIUM, PLATINUM–INDIUM, AND PLATINUM–TIN ALLOYS. Harris, I. R.; Norman, M.; Bryant, A. W. (Univ. of Birmingham, Eng.). J. Less-Common Metals, 16: 427-40(1968).

The room temperature lattice spacings and magnetic susceptibilities of some Pd–In alloys, and the room temperature lattice spacings of some Pt–In and Pt–Sn alloys, have been examined in the present work. Extensive primary solid-solubility of indium and tin in α-palladium and α-platinum has been found and whereas indium expands the lattice of α-palladium to a slightly greater extent than tin, in the α-platinum solid solutions, larger expansions were obtained in the case of the tin alloys. The phases Pt_3Sn and Pt_3In have the ordered LI_2-type structure whereas Pd_3In has a face-centered tetragonal (fct) structure but is face-centered cubic (fcc) in the deformed (as-crushed) state. It was not possible to determine whether Pd_3In is ordered because of the closely similar scattering factors of palladium and indium. The axial ratio of tetragonal Pd_3In decreases with increasing temperature. The magnetic susceptibilities of the α Pd–In alloys have been correlated with the effective valency of the alloys and deviations from the behavior expected from the simple rigid band model occur at indium contents in excess of 8 at. %. The Pd–In B2-type phase exists over an appreciable composition range (~16 at. %), and the variation of the lattice spacings over this range indicated that constitutional vacancies are probably formed at indium contents in excess of 50 at. %. The structures and lattice spacings of the phases Pd_2In_3, $PdIn_3$, Pt–Sn and $PtSn_2$ have also been determined in the present work. (auth)

14358 REFINEMENT OF A Th_2Ni_{17}-TYPE STRUCTURE: $CeMg_{1.03}$. Johnson, Quintin; Smith, Gordon S. (Univ. of California, Livermore). Contract W-7405-eng-48. Acta Crystallogr., 23: 327-9(Aug. 1967). (UCRL-70228).

The Th_2Ni_{17}-type structure found in the cerium-magnesium system has been studied by conventional single-crystal techniques. The space group is $P6_3/mmc$; unit cell constants are a = 10.33, c = 10.25 Å. The actual composition is $CeMg_{10.3}$; this is achieved mainly by substitution in the Th_2Ni_{17} structure of two magnesium atoms for one cerium atom a certain percentage of the time. The agreement of this work with earlier work on a barium–magnesium compound but disagreement with earlier work on uranium–zinc and plutonium–zinc compounds indicates that structures of the Th_2Ni_{17}-type may actually be two (or more) closely related structures. (auth)

14359 PHASE INVESTIGATIONS IN THE SYSTEM ZIRCONIUM–TUNGSTEN. Chang, Y. A. (Univ. of Wisconsin-Milwaukee, Milwaukee). J. Less-Common Metals, 17: 325-8(Mar. 1969).

High-temperature phase relations were investigated in the Zr–W system using melting-point and x-ray methods. (M.C.G.)

14360 INTERMETALLIC COMPOUNDS IN THE GADOLINIUM–COBALT SYSTEM. Buschow, K. H. J.; Van Der Goot, A. S. (Philips Research Labs., Eindhoven, Netherlands). J. Less-Common Metals, 17: 249-55(Mar. 1969).

The gadolinium–cobalt system was investigated over the whole concentration range by means of x-ray diffraction, thermoanalysis, and metallography. Eight intermetallic compounds were observed: Gd_3Co, Gd_xCo (with $x \approx 1/4$), Gd_4Co_3, $GdCo_2$, $GdCo_3$, Gd_2Co_7, $GdCo_5$ and Gd_2Co_{17}. The compounds Gd_2Co_7 and Gd_2Co_{17} showed a structure

transformation. For all compounds except Gd_xCo the lattice constants and the structure type are given. The compounds $GdCo_5$ and Gd_2Co_{17} possess large homogeneity regions at elevated temperatures. For $GdCo_5$, the variation of the saturation moment and the coercive force within the homogeneity region were studied. High values for the coercive force (up to 43,000 Oe) were observed for some of the other gadolinium–cobalt compounds. (auth)

14361 RARE EARTH BISMUTHIDES WITH $D8_8$ AND Hf_5Sn_3Cu-TYPE STRUCTURES. Hohnke, D.; Parthe, E. (Univ. of Pennsylvania, Philadelphia). J. Less-Common Metals, 17: 291-6(Mar. 1969).

The crystal structures of Nd_5Bi_3, Gd_5Bi_3, La_5Bi_3Cu, Ce_5Bi_3Cu, Pr_5Bi_3Cu, Nd_5Bi_3Cu, Gd_5Bi_3Cu, and Tb_5Bi_3Cu have been determined by x-ray powder diffraction methods. All compounds crystallize in either the normal or the filled $D8_8$ structure type. It is shown that the $D8_8$ structure can be built up using as the only construction element a slightly deformed trigonal $[BiGd_6]$ prism. (auth)

14362 POTASSIUM NIOBIUM FLUORIDE–POTASSIUM CHLORIDE–SODIUM CHLORIDE SYSTEM. Sakawa, Mitsuhiro; Kuroda, Tadashi (Tokyo Inst. of Tech.). Denki Kagaku, 37: 69-72(Jan. 1969). (In Japanese).

Metallic niobium was produced from niobium carbide by molten salt electrolysis, using K_2-NbF_7 electrolytic bath. In order to get the best conditions for the niobium electrolysis, the liquid phase diagram of the $K_2NbF_7-NaCl-KCl$ system was studied by the DTA method. The liquid phase of the K_2NbF_7-KCl system had two eutectic mixtures: 25 mol % and 85 mol % K_2NbF_7 at 692°C. The liquid phase of the K_2NbF_7-NaCl system had three eutectic points, the component: K_2NbF, 25 mol %, 50 mol %, 80 mol %, at: 567, 650, and 670°C respectively. The lowest freezing point of the $K_2NbF_7-NaCl-KCl$ system was 567°C, with the component: K_2NbF_7, 25 mol %, NaCl 75 mol %, KCl O mol %. (NSA of Japan)

14363 THE CHEMICAL ACTIVITIES OF CHROMIUM AND MOLYBDENUM IN SOLID CHROMIUM–MOLYBDENUM ALLOYS. Dickson, D. S. (Air Force Materials Lab., Wright-Patterson AFB, Ohio); Myers, J. R.; Pool, M. J.; Saxer, R. K. Trans. Met. Soc. AIME, 245: 175-7(Jan. 1969).

Thermodynamics and chemical activities of Cr–Mo alloys as evidenced by allotropy and vapor pressures were determined at 1623 to 1773°K. Data are given on Cr vapor pressure and integral free energies, entropies, and heats of mixing in the Cr–Mo system at 1673°K. (J.R.D.)

14364 THE AGING PRECIPITATION PROCESS OF THE Fe–Be ALLOY. Hirano, Kenichi (Tohoku Univ., Sendai). Tetsu To Hagane, 54: No. 10, 389-91(Aug. 1968). (In Japanese).

The aging precipitation processes of Fe–Be alloys are described. In the equilibrium diagram of Fe–Be alloys, on the Fe side, it is shown that the final stable precipitated phase from the super-saturated α-phase is the Be_2Fe phase. In experiments on 21 at. % Be alloy and 27 at. % Be alloy differences appeared in the mechanism of the age hardening at 400 ~ 500°C. When 27 at. % Be alloy was quenched at 1150°C ice water containing salt, solutionized, and aged at 362°C, it was found that the appearance of the irregular structure contributed to hardness. Results of the experiments on the precipitation processes of 25 at. % Be alloy and of 11 and 29 at. % Be alloys are shown. The relation between the granular intermediate phase formed in crystal grains and the formation of the stable phase was not evident. Compression test results showed that the alloys with regular and irregular structures deformed by the formation of twins, while secondary-phase precipitated alloys deformed by slip. (NSA of Japan)

14365 THERMAL-TINTING OF PHASES IN MOLYBDENUM ALLOYS. Nikolaeva, V. N.; Tsvilling, M. Ya. Izv. Vyssh. Ucheb. Zaved., Chern. Met., No. 5, 133-4(1968). (In Russian).

The conditions required for the thermal-tinting of different phases in Mo alloys for purposes of identification are described and some typical results are presented. In the Mo–Cr–Fe–C system, carbides may be distinguished from the δ phase in this way. In the Mo–Si system, a Mo-base phase may also be distinguished from the silicides $MoSi_2$ and Mo_5Si_3. In the Mo–Si–W and Mo–Si–Cr systems the colors of the phases depend on their W (Cr) content. Data related to the Mo–Ni–Si and Mo–Zr–Cr systems are also presented. (J.C.W.)

14366 PHASE-STATE OF ALLOYS FORMED BY REFRACTORY COMPONENTS (AS EXEMPLIFIED BY THE NIOBIUM–MOLYBDENUM PHASE DIAGRAM). Krimer, B. I. Izv. Vyssh. Ucheb. Zaved., Chern. Met., No. 5, 143-5(1968). (In Russian).

The phase diagram of the binary Nb–Mo system was studied by microstructural analysis and x-ray diffraction, together with hardness and electrical resistivity measurements, using samples of irregular shapes. The temperature corresponding to the onset of melting was determined for a wide range of such alloys and interpreted in terms of their phase state. Nb and Mo apparently interact in the solid state to form a continuous series of solid solutions. (J.C.W.)

14367 STRUCTURAL CHANGES IN VANADIUM AND NIOBIUM ROLLED IN VACUUM AND IN HELIUM. Krupin, A. V.; Pavlov, I. M.; Izotov, V. M.; Mel'nikova, L. V. Izv. Vyssh. Ucheb. Zaved., Chern. Met., No. 5, 103-5(1968). (In Russian).

The structures of V and Nb samples rolled in vacuum (various residual pressures) and in commercial-purity He were studied and compared. The structures of samples rolled in He, poor vacuum, or air contained appreciable amounts of a secondary phase, presumably consisting of oxy- and carbo-nitrides. There was no trace of these impurities in the structure of samples rolled in a high vacuum. These results suggest that the development of cracks in hot-worked V and Nb is caused by the absence of protective oxide films and the consequent penetration of harmful gases into the main volume of the metal. (F.S.)

14368 STUDY OF PRODUCTION AT ELEVATED TEMPERATURES OF PURE NICKEL AND NICKEL–ALUMINIUM ALLOYS. INFLUENCE OF IRRADIATION. Silvent, A. (Centre d'Etudes Nucleaires, Grenoble, France). Mem. Sci. Rev. Met., 65: 733-43(Oct. 1968). (In French).

The influence of low aluminum additions on the mechanical properties of nickel at elevated temperatures was investigated. Changes in the deformation and fracture characteristics and effects of neutron bombardment were studied. Mechanisms of embrittlement were established. (tr-auth)

14369 MOESSBAUER EFFECT STUDY IN Cu–12.6 PERCENT Be–0.2 PERCENT Co–0.1 PERCENT Zn ALLOY. Nasu, Saburo; Murakami, Yotaro; Yoshida, Hiroyuki (Kyoto Univ.). Jap. J. Appl. Phys., 8: 282-3(Feb. 1969).

In order to study Co atoms contained in Cu–Be alloys, ^{57}Fe Moessbauer work was done using a specimen doped with ^{57}Co. A Cu–Be 12.6%–Co 0.2%–Zn 0.1% alloy was prepared. For the gamma source, ^{57}Co was electroplated onto the plate of this alloy, and a stainless steel foil was used as an absorber. The results indicate that the Co atoms are dissolved and isolated in the Cu–Be alloy matrix. (M.H.R.)

14370 THE CRYSTAL STRUCTURE OF $Ho_{11}Ge_{10}$. Smith, Gordon S.; Johnson, Quintin; Tharp, A. G. (Univ. of California, Livermore). Contract W-7405-eng-48. Acta Crystallogr., 23: 640-4(Oct. 1967). (UCRL–70356).

The crystal structure of a compound in the holmium–germanium system near 1:1 stoichiometry has been determined by single-crystal x-ray diffraction techniques. The composition established is $Ho_{11}Ge_{10}$. The unit cell is body-centered tetragonal, and contains four $Ho_{11}Ge_{10}$ units. Lattice constants are a = 10.79, c = 16.23 Å; the calculated density is 8.93 g cm^{-3}. The space group as deduced from the structure analysis is I4/mmm. Germanium atoms in the structure are of three types: (1) isolated atoms; (2) pairs of atoms (bond lengths 2.54 and 2.96 Å); and (3) a square cluster of four atoms (bond length 2.58 Å). Infinite chains of Ge atoms found in CrB-type HoGe do not occur in $Ho_{11}Ge_{10}$. Coordination numbers of Ge atoms are either 8 or 9; of Ho, 15–17. (auth)

Radiation Effects

Refer also to abstracts 13962, 14368, and 15625.

14371 (WAPD-Trans-107) STUDY OF DEFECTS PRODUCED IN BERYLLIUM BY IRRADIATION AT LOW TEMPERATURE. Nicoud, J. C.; Delaplace, J.; Hillairet, J.; Schumacher, D. Translated from J. Nucl. Mater., 27: 147-65(1968). 39p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 22: 28866. (R.C.K.)

14372 (WCAP-3677-9) FRACTURE MECHANICS EVALUATION OF REACTOR VESSEL STEELS. Quarterly Progress Report for the Period Ending September 30, 1968. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Oct. 1968. Contract AT(30-1)-3677. 38p. (EURAEC-2069). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

An experimental program to further develop and evaluate a fracture mechanics approach to the problem of brittle fracture of reactor pressure vessel materials, based on the use of modified Wedge Opening Loading (WOL) specimens, is described. Experimental testing of a group of reactor pressure vessel steels is being performed to investigate the application of the fracture mechanics technique to these materials in both the unirradiated

and irradiated conditions. The method for irradiating the test specimens is described. The three materials tested were ASTM A533 Grade B steel from 8 in. thick plate, European 1.2 MD07 forging grade steel, and weld metal from ASTM A533 Grade B Class I steel. Experimental results on the tensile properties and fracture toughness of these materials for both pre- and post-irradiation conditions are given. Also given are pre-irradiation fracture toughness test results for specimens from 12 in. thick plate of A533, grade B, class 1 steel. (L.C.L.)

14373 FIELD-ION MICROSCOPY OF RADIATION DAMAGES IN SINGLE TUNGSTEN CRYSTAL IRRADIATED BY 12 MeV ENERGY DEUTERONS. Kuznetsov, V. A.; Kukavadze, G. M.; Stasevich, B. M.; Suvorov, A. L. At. Energ. (USSR), 26: 22-4 (Jan. 1969). (In Russian).

An investigation has been made on radiation damages in a single tungsten crystal irradiated by 12 MeV energy deuterons through the use of a low-temperature field-ion microscope with helium as an image gas. The collision of a deuteron with a single tungsten crystal has been found to result in short-term thermal heating of a local region. Deuteron-irradiation of tungsten brings about the formation of displacement areas, defects accumulations, single vacancies, interstitial atoms, and many dislocations which result in considerable shifts in the crystal lattice. (tr-auth)

14374 MATERIALS ENGINEERING FOR NUCLEAR POWER. Ziebold, Thomas O. (Massachusetts Inst. of Tech., Cambridge). Technol. Rev., 70: 25-9(Apr. 19, 1968).

Along with nuclear fuels, the use of many materials in nuclear reactors, including the more familiar structural alloys, has required development of new or improved technologies. For good neutron economy, structural materials in the reactor core must not excessively absorb neutrons. On the other hand, control materials capable of absorbing neutrons strongly are needed for controlling the power level of a reactor. Reliability requirements have directed development efforts not only towards newer materials but also towards improving the quality of common structural alloys. The exploration of the microscopic nature of radiation damage was initiated. A cryogenic facility will permit intense irradiation of solid samples kept in a bath of liquid helium, near 4°K. The other part of this facility consists of a moderator assembly refrigerated by cold helium gas, which will serve as a source of very slow neutrons. A schematic arrangement of the reactor cryogenic assemblies is given. Cold neutron studies include measurements of fundamental properties of the neutron, elastic scattering for structural studies and interaction effects, inelastic scattering to investigate internal vibrations of molecules and atomic motions in condensed solids, and possibly determination of whether or not there is an electric dipole moment in the neutron. (BBB)

14375 TEMPERATURE/EXPOSURE THRESHOLDS FOR CAVITATIONAL SWELLING OF DILUTE URANIUM ALLOYS. McDonell, W. R.; Rankin, W. N.; Angerman, C. L.; Huntoon, R. T. (E. I. Du Pont de Nemours and Co., Aiken, S. C.). J. Inst. Metals, 97: 22-5(Jan. 1969).

Uranium alloys containing <1000 ppM of Fe, Si, Al, Cr, and Mo were irradiated at center temperatures of 200 to 500°C for exposures up to 5000 MWD/T. The critical dependence of the swelling on the temperature and exposure is shown. The effects of composition and heat treatment are described. (UK)

14376 EFFECT OF ALLOYING ADDITIONS ON ANISOTROPIC GROWTH OF URANIUM. McDonell, W. R.; Rankin, W. N.; Huntoon, R. T. E. I. Du Pont de Nemours and Co., Aiken, S. C.). J. Inst. Metals, 97: 26-9(Jan. 1969).

Uranium alloys containing <1000 ppM of Fe, Si, Al, Cr, and Mo were irradiated at center temperatures of 200 to 500°C for exposures up to 5000 MWD/T. The effect of alloy composition and heat treatment on anisotropic growth, as measured by changes in length, are discussed. The dependence of average growth rates (length change/1000 MWD/T) on texture is illustrated. A correlation is indicated between growth coefficients and cavitation swelling. (UK)

14377 NEUTRON IRRADIATION EMBRITTLEMENT OF STRUCTURAL STEELS IN NUCLEAR POWER REACTOR. Kawasaki, Masayuki; Fujimura, Tadato (Japan Atomic Energy Research Inst., Tokai). Trans. Iron Steel Inst. Jap., 8: 48-56 (1968).

Results of irradiation tests made at the Japanese Research Reactor-2 are given for ASTM A302B steel, aluminum-killed steel, the pressure vessel steel of the Tokai Reactor and their weld metals. The facility used, the test rig, and the apparatus used in post-irradiation testing are described. It was found: that the transition temperature for brittle fracture of the steel shifts to lower temperatures by the irradiation of low fast-neutron doses from 10^{15} to 10^{16} n/cm^2; with increased dose beyond 10^{18} n/cm^2, the transition temperature shifts to higher temperatures; and the radiation effect on weld metals is larger than for base metals. (F.S.)

Ceramics and Cermets

Preparation and Fabrication

Refer also to abstracts 13948, 14309, 14310, 14412, 15600, 15678, and 15679.

14378 (ALO-2510-3) SILICON GERMANIUM THERMOELECTRIC MATERIALS AND MODULE DEVELOPMENT PROGRAM. Third Quarterly Report, July 1, 1968-September 30, 1968. (Radio Corp. of America, Harrison, N. J. Special Electronic Components Div.). Contract AT(29-2)-2510. 59p. Dep. CFSTI.

Research directed toward characterization and improvement of the SiMo hot shoe materials and refinement of the fabrication and bonding techniques is reported. A spectrographic technique for the quantitative analysis of B in SiGe was developed. Various phases of the SiMo alloy were identified by electron microprobe. Thermal conductivity and electrical resistivity of silicon carbide, SX-4 graphite, and SiMo(n-TYPE) were determined as functions of temperature. A four-couple reference design module with graphite hot shoes was fabricated. Performance test results obtained for Reference Design converter closely correlated with analytical projections of output. A high L/A (50 cm^{-1}) thermocouple and a four-couple module were completed. Fabrication of a 5-watt foil-insulated converter was begun. The relative efficiency test device was completed and testing of the four-couple Reference Design module was initiated. Codes for computer analysis of radiantly coupled cascade systems were completed and applied to SiGe air-vac couples cascaded with Isotec panels. (J.C.W.)

14379 (GAMD-8330) PROCESS STUDIES FOR LOADING BONDED BED FUEL RODS. Hooker, J. R.; Stevens, D. W. (Gulf General Atomic, Inc., San Diego, Calif.). Nov. 1, 1967. Contract AT(04-3)-633. 41p. Dep. CFSTI.

Several methods of blending and loading fissile and fertile coated fuel particles were considered for the preparation of Public Service Co. of Colorado reactor fuel rods. The development of three general processes and their characterization are described. All three processes yield nearly nominal packing fractions, low coated particle breakage and fissile-fertile uniformities within tolerance; however, the simultaneous metering of dry, fissile and fertile coated particles give the best results. (auth)

14380 (Y-DA-2679) FABRICATION OF GRAPHITE FIBER REINFORCED GRAPHITE COMPOSITES. Cook, J. L.; Lambdin, F. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Jan. 10, 1969. Contract W-7405-eng-26. 12p. (CONF-690306-1). Dep. CFSTI.

From WESTEC Conference of the American Society for Metals, Los Angeles, Calif.

Composites consisting of graphite fibers (2 μD × 0.010" L) and either a thermoplastic or thermosetting resin were spray formed onto graphite mandrels carbonized to 1,000°C, and densified as desired by repeated resin impregnation-carbonization cycles. Sections up to one inch in thickness and ranging in density from 0.2 to 1.7 g/cc have been fabricated using spraying as the basic fabrication method. Isostatic and match-die compaction were used to increase the fiber population. Preliminary physical and mechanical properties of these composite materials were evaluated. (auth)

14381 METHOD AND APPARATUS FOR THE HEAT TREATMENT OF POWDERY SUBSTANCES BY MEANS OF A HIGH TEMPERATURE PLASMA. (to Gesellschaft fuer Kernforschung mbh). British Patent 1,142,793. Feb. 12, 1969. Priority date June 28, 1965, Germany.

A method and an apparatus are described for heat treatment of powdery substances to melt the angular granules and form them into spherical shape by means of a plasma. The powdery substance is finely distributed in a carrier gas and conveyed into the plasma. The powdery substance and the gas are heated separately and then mixed together. The apparatus includes preheating and mixing devices and a plasma device. Ceramic reactor fuels may be prepared in this way. (F.S.)

14382 EXTRUDED GRAPHITE MATRIX CONTAINING COATED PARTICLES. Smith, Mark J. (to Air Reduction Co., Inc.). U. S. Patent 3,419,468. Dec. 31, 1968. Filed July 6, 1967.

A nuclear fuel rod of heterogeneous composition and predetermined length is described consisting of nuclear fuel particles with

unbroken coatings distributed throughout an extruded graphite matrix. (Offic. Gaz.)

14383 FUEL MATERIALS FOR NUCLEAR REACTORS. Hazelden, Denis William John; Norreys, John Jephson; Wheeler, Michael John (to General Electric Co., Ltd.). U. S. Patent 3,418,245. Dec. 24, 1968. Priority date May 2, 1966, Great Britain.

A fuel material for a nuclear reactor is composed of uranium or plutonium, or both uranium and plutonium, together with niobium and carbon, in relative atomic proportions substantially in the range of (51−x) percent M : x percent niobium: 49% carbon to (48−x) percent M : x percent niobium: 52% carbon, in which M consists of uranium and/or plutonium and the value of x is in the range of 0.1 to 8.0 atomic percent, the fuel material consisting wholly or mainly of a solid solution of niobium monocarbide with uranium monocarbide and/or plutonium monocarbide. Several methods of manufacturing the fuel materials are described. (auth)

14384 PYROLYTIC CARBON COATING IN AN ENGINEERING-SCALE SYSTEM. Pratt, R. B.; Pechin, W. H.; Sease, J. D.; Lotts, A. L. (Oak Ridge National Lab., Tenn.). Nucl. Appl., 6: 241-55 (Mar. 1969).

Work is described concerning production of coated-particle fuels for use in high-temperature gas-cooled reactors (HTGR's) and a coating system that has served as the basis for the design of a remotely operated recycle fuel fabrication system. An ability was demonstrated to deposit low- and high-density pyrolytic carbon coatings having a variety of properties on a scale adequate to satisfy the proposed Thorium Uranium Recycle Facility production rate of 10 kg heavy metal fuel per day. An engineering scale, 5-in.-ID fluidized bed coating furnace was designed along with its auxiliaries. Process controlling parameters were also identified and their effects on inner and outer coating properties produced from acetylene, propane, and propylene were demonstrated. Specific coating properties controlled were density, thickness, anisotropy factor, coating rate, and deposition efficiency. Parameters identified include: bed temperature, gas purity, gas flux, inert-gas dilution, charge size, kernel composition, kernel size, and components configuration. (auth)

14385 BEHAVIOR OF BISMUTH BONDING BETWEEN POWDER COMPACTED CERAMIC FUEL AND CLADDING. Kubota, Tadashi; Takahashi, Shuichiro (Mitsubishi Atomic Power Industrial, Inc., Omiya, Japan). Nippon Genshiryoku Gakkaishi, 10: 678-83 (Dec. 1968).

Evaluation by out-of-pile heating was made on two types of bismuth heat transfer bonding between powder compacted ceramic fuel and cladding, prepared by vibration compacting a mixture of UO_2 powder and bismuth powder in cladding tube, and by vibration compacting of ceramic fuel powder in cladding tube with bismuth lamella formed on the inner surface of cladding. In the first case, the bismuth originally distributed in the central region of the compact (2,600 ~ 2,700°C) evaporated and moved toward the periphery (800 ~ 900°C) where it assembled to serve as good liquid heat transfer medium. In the second case, the bismuth lamella served as good liquid heat transfer medium without permeating into the inner regions of the compact. There was no appreciable reaction between the bismuth and UO_2 up to 2,600 ~ 2,700°C, nor between the bismuth and UN or UC up to 1,200 ~ 1,300°C. (NSA of Japan)

14386 REACTIVELY SPUTTERED OXIDE FILMS. Lieberman, M. L.; Medrud, R. C. (Corning Glass Works, Corning, N. Y.). J. Electrochem. Soc., 116: 242-7 (Feb. 1969).

Oxide films of eleven metals were prepared by reactive sputtering. The use of refrigerated substrates resulted in amorphous films in eight of the metal−oxide systems. Crystallization of the amorphous films give rise to metastable, high-temperature polymorphs of WO_3, Ta_2O_5, and Bi_2O_3, and an unidentified tellurium oxide phase. High-oxidation-state compounds of silver, antimony, and lead were prepared. Optical properties of some films were examined. Films with a high refractive index and low optical absorption were prepared by crystallization of the highly absorbing, amorphous, bismuth oxide films. (auth)

14387 MACHINING AN UNUSUAL CERAMIC. Ind. Diamond Rev., 29: 116-7 (Mar. 1969).

A brief account is given of the diamond tools used by the National Beryllia Corp. of New Jersey in the manufacture of BeO components. (UK)

14388 NUCLEAR FUEL PARTICLES MADE OF COKE GRANULES IMPREGNATED WITH METAL CARBIDES. Bildstein, H.; Knotik, K. (Institut fuer Chemie, Seibersdorf, Austria). Kerntechnik, 10: 676-80 (Dec. 1968). (In English and German).

A method is described for manufacturing carbon-metal carbide particles, with particular reference to carbon−uranium carbide particles. The process is based on the use of fluid coke particles formed in cracking crude oil. These particles are impregnated with the desired metal carbide by means of a thermal process. Particles treated in this manner, owing to their advantageous porosity, are suitable for the manufacture of high temperature reactor fuels. (auth)

14389 URANIUM DIOXIDE CRYSTALS GROWN BY A SOLAR FURNACE. Sakurai, Takemaro; Kamada, Osamu; Ishigame, Mareo (Tohoku Univ., Sendai). J. Cryst. Growth, 2: 326-7 (Oct. 1968).

Uranium dioxide powder pressed into a cube 1 cm^3 in dimension was irradiated by a large solar furnace. By irradiation, minute single crystals grew which had a pyramidal form with optically flat crystal surfaces. Some considerations on the crystal growth process are also presented. (auth)

14390 VAPOUR GROWTH OF SINGLE CRYSTALS OF WO_3 AND MoO_3. Wanklyn, Barbara M. (Oxford Univ.). J. Cryst. Growth, 2: 251-3 (Aug. 1968).

Growth of large plates of single crystals of MoO_3 and WO_3 by vapor deposition is described. The plates of WO_3 were 2 cm × 2.5 cm by 0.7 mm thick with a color variation from dark to pale olive green. Domain structure due to crystallographic transition below the deposition temperature was visible. The plates of MoO_3 which were grown were 10 × 3 × 0.2 mm. The untwinned crystals were transparent with no domain structure. (F.S.)

14391 TRI-ARC FURNACE FOR CZOCHRALSKI GROWTH WITH A COLD CRUCIBLE. Reed, T. B.; Pollard, E. R. (Massachusetts Inst. of Tech., Lexington). J. Cryst. Growth, 2: 243-7 (Aug. 1968).

A crystal puller using the arc-melting technique has been developed for the Czochralski growth of single crystals. The circumference of the melt is heated by three arcs, and the crystal is pulled from the center of the melt with a water-cooled seed rod. The charge is contained in a hollow water-cooled copper hearth fitted with a piston so that the melt can be continuously fed. Use of this apparatus eliminates the difficulty of finding crucible materials suitable for high-temperature growth, since the melt is contained by a solid shell of the same substance in contact with the hearth. The furnace is economical, convenient to use, and requires a relatively small mass of material. Boules of Sn, Ge, Si, Cu_2O, V, VO, Ti_2O_3, Ni, Nb, NbO, and TiC, with melting points between 232 and 3150°C, have been grown. A number of good quality crystals of NbO with various stoichiometries were grown for measurement of the electrical properties. Mass spectrographic analysis of grown crystals usually shows no copper or tungsten above 10 ppM, the limit of detection. Silicon crystals grown on a graphite hearth have a resistivity of about 10 ohm-cm suggesting that the concentration of electrically active impurities introduced from the arc or hearth does not exceed 0.1 ppM. The tri-arc modification also has advantages for other uses such as ordinary arc melting, freeze purification, arc casting, "splat cooling," arc-Verneuil crystal growth and zone refining. (auth)

14392 PREPARATION AND STRUCTURAL CHARACTERISTICS OF THE MIXED OXIDE $Pb_3Fe_2UO_9$. Berthon, Jacques; Poix, Paul (Laboratoire de Chimie Minerale, Orsay, France). Compt. Rend., Ser. C, 267: 1585-6 (Dec. 4, 1968). (In French).

The mixed oxide $Pb_3Fe_2UO_9$ of perovskite structure was synthesized. The unit cell contains eight $PbFe_{\frac{1}{4}}U_{\frac{1}{4}}O_3$ groups with a = 8.140 ± 0.001A. (tr-auth)

Properties Evaluations

Refer also to abstracts 13693, 14326, 14380, and 15738.

14393 (BNWL-927) THE EFFECT OF OXYGEN STOICHIOMETRY ON THE THERMAL DIFFUSIVITY AND CONDUCTIVITY OF $U_{0.75}Pu_{0.25}O_{2-x}$. Gibby, R. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan. 1969. Contract AT(45-1)-1830. 55p. Dep. CFSTI.

The effect of oxygen content on the thermal diffusivity (α) of $U_{0.75}Pu_{0.25}O_{2-x}$ was measured for values of x from 0.00 to 0.07 at temperatures from 100 to 1200°C. Corresponding values of thermal conductivity (λ) were calculated from the thermal diffusivity data using estimated values for the heat capacity of the mixed oxide. Thermal diffusivity and conductivity were observed to decrease with decreasing oxygen content and increasing temperature, obeying the empirical relationships: $1/\alpha = 0.110T + 1.08 \times 10^3x + 4$ (sec/cm²) and $1/\lambda = 0.0312T + 3.55 \times 10^2x + 1.5$ (cm-°k/W) with T expressed in °C and x representing the amount of missing oxygen. The dependence of thermal conductivity on oxygen content was shown to be associated with oxygen ion vacancies and Pu^{+3}

ions which form as oxygen are removed from the lattice. The calculated thermal resistances are in reasonable quantitative agreement with values estimated using the Klemens–Callaway model for phonon scattering by point defects. (auth)

14394 (GA-8681) RESEARCH ON GRAPHITE. Annual Report, May 15, 1967–May 14, 1968. Bokros, J. C.; Engle, G. B.; Price, R. J.; White, J. L. (Gulf General Atomic, Inc., San Diego, Calif.). May 22, 1968. Contract AT(04-3)-167. 144p. Dep. CFSTI.

Studies were conducted on the effects of heat treatments on the mesophase microstructures that develop in an extracted impregnating pitch and the material was subjected to densitometric separation. The characterization of the degree of graphitization of carbons and graphites was performed. Changes in density, electric resistivity, apparent crystalline size, and layer spacing were determined for pyrolytic carbon. Data on the influence of pitch-binder content on the properties and irradiation behavior of molded graphite bodies are summarized. A general equation is proposed that relates the bulk volume changes of porous artificial graphites to the volumetric changes of the crystallites or mosaic clusters of crystallites and the porosity. Isochronal annealing between 400 and 2600° has been completed on a series of neutron-irradiated pyrolytic carbons having a wide range of structures. Radiation-induced dimensional changes in single-phase carbons and graphites are examined. (J.C.W.)

14395 (RD/B/N-1193) SELF-LUBRICATING COMPOSITE MATERIALS FOR HIGH TEMPERATURE APPLICATIONS. Houghton, J. E. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Dec. 1968. 13p. Dep. CFSTI.

Composites were produced by hot-pressing mixtures of powders, by flame spraying mixtures of powders, and by vacuum impregnation of a porous matrix using a molten lubricant. A matrix of Ni or stainless steel was used, with graphite or other lamellar lubricants. Impact strength of the bulk composites, and friction and wear behavior of all composites were determined at 400°C in dry CO_2. Composites produced from lubricant powder precoated with nickel by hot-pressing or flame spraying appear most promising. (UK)

14396 (RD/B/N-1213) MODEL OF THE WEAR OF TWO-PHASE SELF-LUBRICATING COMPOSITES. Mitchell, L. A. (Central Electricity Generating Board, Berkeley (England)). Berkeley Nuclear Labs.). Nov. 1968. 14p. Dep. CFSTI.

The model proposed assumes two mechanisms of wear: a microscopic wear process which occurs at the surface and yields wear particles small compared with the typical dimensions of individual particles within the composite, and a macroscopic process in which failure occurs within the body of the composite, yielding relatively large fragments. For low lubricant contents the microscopic wear process is predominant, whereas for high lubricant contents the converse is true. The existence of the two wear processes gives rise to a minimum wear rate at some intermediate composition. Both qualitative and, to some extent, quantitative agreement was found with experimental results. (UK)

14397 (USBM-RC-1361) ELECTRICAL RESISTIVITY OF HYPERSTOICHIOMETRIC ZIRCONIUM CARBIDE MATERIALS TO 2,000°C. Period Covered: November 1, 1967–November 1, 1968. Paulson, D. L.; Asai, G. (Bureau of Mines, Albany, Oreg. Albany Metallurgy Research Center). Nov. 1968. Contract AT-(11-1)-599. 35p. Dep. CFSTI.

Electrical resistivity measurements were made on arc-melted, spin-cast, and hot-pressed zirconium carbide-carbon (ZrC-C) materials in the temperature range of 20° to 2,000°C. The hot-pressed materials were tested with current applied parallel with and perpendicular to the pressing axis. The ZrC-C materials displayed electrical resistivity values ranging from 29 micro ohm-centimeters at 20°C for arc-cast material containing 16 weight percent carbon to 279 micro ohm-centimeters at 1,951°C for hot-pressed material containing 21 weight percent carbon. (auth)

14398 STRUCTURE AND PROPERTIES OF SOLID SOLUTIONS IN THE INTERVAL LA_2Te_3–La_2CeTe_4. Aloman, Angel (Polytechnic Inst., Bucharest). Bull. Inst. Politeh. Bucuresti, 30: 101-6(Mar.-Apr. 1968). (In Rumanian).

Results are presented of the first investigation of solid solutions in the interval La_2Te_3–La_2CeTe_4, including the method of synthesis, homogenizing, and preparation of the samples for measurement of the thermoelectric properties. For the materials obtained, the lattice parameters, density, resistivity, thermoelectrical power, thermal conductivity, and Hall constant were determined. The thermoelectric power coefficient, the figure of merit, the mobility, and the concentration of the carriers were also calculated. The materials in the investigated interval present a gradual passing from semiconductive properties to semimetallic properties, and the chemical bond ranges from iono-covalent to metallic-ionocovalent. (auth)

14399 PARTIAL DISLOCATIONS IN SUB-STOICHIOMETRIC TANTALUM CARBIDE. Martin, J. L.; Jouffrey, B. J. Phys. (Paris), 29: 911-16(Oct. 1968). (In French).

It has been shown that intrinsic stacking faults are present in a nonstoichiometric carbide ($TaC_{0.75}$). A study of the detailed orientation of partial dislocations reveals that stacking faults are bounded by Shockley dislocations. It is concluded that the observed faults are due to a shear. The presence of widely dissociated nodes suggest that the stacking fault energy is low in this composition range. (auth)

14400 PREPARATION, OPTICAL, AND DIELECTRIC PROPERTIES OF VAPOR-DEPOSITED NIOBIUM OXIDE THIN FILMS. Duffy, M. T.; Wang, C. C.; Waxman, A.; Zaininger, K. H. (Radio Corp. of America, Princeton, N. J.). J. Electrochem. Soc., 116: 234-9(Feb. 1969).

Thin dielectric films of niobium oxide were deposited on silicon and quartz substrates by pyrolysis of the niobium alcoholate $Nb(OC_2H_5)_5$ at 450°C in an oxidizing ambient. Optical measurements were made on these films in the spectral range 0.2 to 2.6 μm. Information on dispersion, fundamental absorption edge, and absorption coefficient (as related to photon energy) was obtained. An electrical evaluation of the films was made, including dielectric properties and metal-oxide-silicon (MOS) behavior. (auth)

14401 THERMAL EXPANSION OF STABILIZED ZIRCONIUM DIOXIDE AT 300 TO 2600°K. Shakhtin, D. M.; Levintovich, E. V.; Pivovar, T. L.; Eliseeva, G. G. (Scientific-Research Inst. of Refractory Materials, Kharkov). Izv. Akad. Nauk SSSR, Neorg. Mater., 4: 1603-4(Sept. 1968). (In Russian).

Thermal expansion of pure 99.8% ZrO_2 stabilized by 6 wt. % CaO and the influence of Al_2O_3, TiO_2, Fe_2O_3, and SiO_2 contents on industrial ZrO_2 were analyzed at room temperature to 2600°K. Data obtained showed that additions of 1 to 2 wt % of Al_2O and TiO_2 and impurities of 0.25 to 1.0 wt % Fe_2O_3 do not influence the thermal expansion of stabilized zirconium dioxide. Additions of 1 wt % SiO did not affect the thermal expansion of ZrO_2; however, 2 wt % disturbed the linear character of expansion and at 1400°K the expansion was replaced by contraction. Tabulated data are given on the expansion of pure ZrO_2 stabilized by 6 wt % CaO at 293 to 2600°K. (R.V.J.)

14402 PROPERTIES OF DEPOSITED COATINGS OF STABILIZED ZIRCONIUM DIOXIDE. Ezerskii, M. L.; Kolesnikov, E. I.; Shklyarevskii, E. E.; Rastorguev, L. N. Izv. Akad. Nauk SSSR, Neorg. Mater., 4: 1601-2(Sept. 1968). (In Russian).

Structural and electric characteristics of solid solutions of $ZrO_2 \cdot CaO$ prepared by plasma spraying were investigated at 600 to 1000°C using four specimens of powdered stabilized zirconium oxide with 10, 12, 15, and 18 mole % CaO. The electric conductivity of $ZrO_2 \cdot CaO$ at 1000°C reached a maximum with 12 mole % CaO. The resistance of specimens with 15 and 18 mole % CaO prepared by plasma deposition was much higher than that of material prepared by coking. (R.V.J.)

14403 ON CERTAIN CERAMIC PROPERTIES AND ELECTRIC CONDUCTIVITY OF ZIRCONIUM CERAMICS STABILIZED BY YTTRIUM OXIDE. Ezerskii, M. L.; Kozlova, N. I.; Popil'skii, R. Ya.; Demonis, I. M. Izv. Akad. Nauk SSSR, Neorg. Mater., 4: 1599-1600(Sept. 1968). (In Russian).

Electric conductivity and x-ray structural analysis were made of zirconium ceramics stabilized with Y_2O_3 contents of 8 to 12 mole % and sintered at 1750°C. Tabulated data on strength, electric conductivity, and thermal expansion of the specimens are included. It is shown that the electric conductivity depends on the content of Y_2O_3 and the minimum electric resistance was found with 10 mole % Y_2O_3. Thermal treatment of solid solutions of ZrO_2–Y_2O_3 at 1200 and 1375°C did not reveal any phase composition changes. (R.V.J.)

14404 AN INVESTIGATION OF THE YIELD STRENGTH OF A DISPERSION-HARDENED W-3.8 VOL PCT ThO_2 ALLOY. King, George W. (Westinghouse Electric Corp., Bloomfield, N. J.). Contract AF33(615)-1698. Trans. Met. Soc. AIME, 245: 83-9 (Jan. 1969).

The yield strength of a dispersion-hardened W-3.8 vol % ThO_2 alloy, in both the recovered and recrystallized condition, was investigated and compared with that of recrystallized pure tungsten at 325 to 2400°C. It is deduced that the Orowan mechanism is obeyed in the recrystallized alloy. In the recovered alloy, a further enhancement of the yield strength results from the retained substructure which is stable up to temperatures in excess of 2700°C. Temperature and strain rate cycling tests were also

performed, and the apparent activation energy for the deformation process was derived. This activation energy, ~3 eV, for the recovered and also the recrystallized alloy was about the same as that for recrystallized pure tungsten. However, the activation volume of the recovered alloy, $\sim 10^{-22}$ cm^3, was about an order of magnitude lower than that of the recrystallized alloy or pure tungsten. This fact accounts for an enhancement of the temperature dependence of the yield stress of the recovered alloy. A dislocation velocity exponent of about 4 to 13 was deduced from the strain rate cycling tests, which is in good agreement with values reported for tungsten single crystals. (auth)

14405 MONTE CARLO CALCULATIONS OF CONFIGURATIONAL ENTROPIES IN INTERSTITIAL SOLID SOLUTIONS. Oates, W. A.; Lambert, J. A.; Gallagher, P. T. (Univ. of Newcastle, New South Wales, Australia). Trans. Met. Soc. AIME, 245: 47-54(Jan. 1969).

Monte Carlo methods have been used to compute the arrangements of interstitial atoms dissolved in tetrahedral sites in bcc lattices. It is assumed that the presence of an interstitial atom blocks a certain number of neighboring sites and prevents their occupancy. Sites blocked by more than one filled site are allowed for. The computed values of the mean occupation number $\bar{z}$ (defined as the ratio of the total number of sites blocked to the number of solute atoms) are used to calculate the configurational entropies of the solutions. These entropies are compared with those resulting from previous theoretical studies of this problem and also with available experimental data for the β Zr–H, Nb–H, V–H, and Ta–H systems. Evidence is also given that low limiting compositions in these systems arise due to blocking effects rather than to initial limitations on the number of sites available. (auth)

14406 THE ADSORPTION OF HELIUM, ARGON, AND NITROGEN ON GRAPHITE. Hellemans, R.; Van Itterbeek, A.; Van Dael, W. (Instituut voor Lage Temperaturen en Technische Fysica, Louvain, Belgium). Physica, 34: 429-37(1967).

Adsorption isotherms of He, Ar, and N_2 on graphite are measured at 90 to 17°K, at 10^{-3} to 1 torr. From these experimental data, isosteric heats of adsorption are calculated. Theoretical values of the heat of adsorption are evaluated for He, Ar, N_2, H_2, and D_2 using a potential model worked out by Crowell and Steele. The heats of adsorption derived from the experiment and the theoretical values are in agreement. (auth)

14407 THERMAL PROPERTIES OF ALUMINUM OXIDE-BASE METAL CERAMICS IN THE TEMPERATURE RANGE OF 473 TO 1673°K. Osipova, V. A.; Pak, M. I. At. Energ. (USSR), 26: 72-3(Jan. 1969). (In Russian).

Thermophysical properties (the thermal conductivity λ and temperature conductivity a coefficients of Al_2O_3 + 10% Mo and Al_2O_3 + 30% Mo were studied at 200 to 1400°C. The measurements of the mean temperature and the drop in temperature in the specimen were measured by means of chromel–aluminum thermocouples 0.3 mm in diameter and tungsten thermopairs WP-5/WP-20 0.35 mm in diameter, at absolute pressure of $\sim 5 \times 10^{-3}$ mm Hg. The results showed that an increase in Mo composition, the coefficient of thermal conductivity increased. (R.V.J.)

14408 MEASUREMENT OF THE FREE ENERGY OF STANDARD FORMATION OF NIOBIUM OXIDES NbO, NbO_2, AND Nb_2O_5 WITH THE OXYGEN CONCENTRATION CELL. Hiraoka, T.; Sano, Nobuo. Tetsu To Hagane, 54: No. 10, 82(Aug. 1968). (In Japanese).

The standard free energies of formation of niobium oxides NbO, NbO_2, and Nb_2O_5 were measured using an oxygen concentration cell. The construction of the cell was as follows: Pt | Nb_2O_5 – NbO_2 or NbO_2 – NbO or NbO – Nb | 0.85 ThO_2 – 0.15 $YO_{1.5}$ | Cr – Cr_2O_3 | Pt. The measured values were converted to oxygen potentials, and are shown in a diagram with the values by other investigators. The values for $\Delta F^0_{NbO_2}$, were higher than those obtained by Worrell. The measured points appear to be correct. During the preparation of the NbO sample, when unoxidized Nb remained in the NbO, the $\Delta F^0_{NbO_2}$ measurement result was lower than the true value. (NSA of Japan)

Structure and Phase Studies

Refer also to abstracts 14365, 14389, and 14404.

14409 (CEA-CONF-1085) OBSERVATIONS AT 100 AND 1000 kV OF THIN FOILS OF SUBSTOICHIOMETRIC UC AND CONTRIBUTION TO THE STUDY OF THE CORROSION INDUCED BY THE PRECIPITATION OF DICARBIDE. Pluchery, M.; Pelissier, J. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires); Watanabe, M. (Japan Electron Optics Lab., Tokyo); Takahashi, N. (Yamanashi Univ., Kofu (Japan)). [nd]. 3p. (In French). (CONF-680942-1). Dep.

From 4th European Regional Conference on Electron Microscopy, Rome, Italy.

Studies were made on the structure of solid solutions of fcc UC. Samples containing UC_2 were extremely sensitive to corrosion by air. However, annealing for several hours at 600°C under vacuum reduced considerably the sensitivity to corrosion. The coexistence of three series of precipitates formed in each of the ⟨100⟩ directions gave place to the formation of twin crystals following the ⟨112⟩ planes of UC_2. Stacking faults were also observed in the precipitates of UC_2, the relation of which with the constraints produced in the matrix are discussed. (P.C.H.)

14410 ISOBARIC TERNARY PHASE DIAGRAMS FOR THE MOLYBDENUM–CARBON–OXYGEN SYSTEM AT 1600°K. Ghosh, A. (Indian Inst. of Tech., Kanpur). J. Less-Common Metals, 17: 329-33(Mar. 1969).

The isobaric Mo–C–O ternary phase diagram was derived. The nature and stabilities of various phases in the system are considered. (M.C.G.)

14411 NEUTRON-DIFFRACTION STUDY OF W_2C RHOMBIC MODIFICATION. Nozik, Yu. E.; Lipin, Yu. V.; Kuvaldin, B. V. (Inst. of Geochemistry, Moscow). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser., No. 6, 30-3(1968). (In Russian).

A neutron-diffraction study was carried out resulting from a low-temperature annealing of α–W_2C hexagonal modification using the rhombic phase of the compound. The emerging of this phase is connected with the ordering of carbide atoms in the structure. It was found that a new modification of W_2C crystallizes in the space group D^{14}_{2h}-Pbcn. The tungsten atoms occupy positions 8(d) with $x = 1/4$, $y = 1/4$, $z = 1/12$, but the carbide atoms –4(c) with $y = 3/8$. (auth)

14412 CRYSTAL GROWTH OF FLUORIDES IN THE LANTHANIDE SERIES. Jones, D. A.; Shand, W. A. (Univ. of Aberdeen, Scotland). J. Cryst. Growth, 2: 361-8(Dec. 1968).

Melting points, structure change temperatures, and lattice parameters for CeF_3, DyF_3, ErF_3, EuF_3, GdF_3, HoF_3, LaF_3, LuF_3, NdF_3, PrF_3, SmF_3, TbF_3, TmF_3, and YbF_3 were measured and are discussed with reference to their effect on the growth of single crystals. Research on production of single crystals of these materials is described. The necessary furnace conditions for materials which can be grown by the Stockbarger or Stober techniques are described, and in cases where these techniques are not applicable, other possible methods are considered. (F.S.)

14413 SOLID SOLUTIONS OF $SrZrO_3$ AND $SrHfO_3$. Berezhnoi, A. S.; Belik, V. Ya.; Gavrish, A. M.; Gul'ko, N. V. (Scientific-Research Inst. of Refractory Materials, Kharkov). Izv. Akad. Nauk SSSR, Neorg. Mater., 4: 1605-6(Sept. 1968). (In Russian).

A constitution diagram of solid solutions of SrO–ZrO_2 was constructed and heat and entropy of $SrZrO_3$ melting was found to equal 16.7 kcal/mole and 5.5 eV/mole, respectively. The melting point for $SrZrO_3$ was found at 2750°C and for $SrHfO_3$ at 2890°C. Tabulated data are given on the composition and properties of Sr(Zr,Hf)O_3 and the liquidus–solidus curves were developed for the studied specimens. (R.V.J.)

Radiation Effects

14414 (EURFNR-467) STUDIES OF UO_2 CREEP UNDER NEUTRON IRRADIATION. Brucklacher, D.; Dienst, W.; Thumbler, F. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material- und Festkoerperforschung). Translation of report PSB-289(Phase Ib). 21p. Dep. CFSTI.

Work performed under United States–Euratom Fast Reactor Exchange Program.

The creep rate of UO_2 under irradiation was calculated from test results and compared with data on the creep rate of non-irradiated UO_2. Mechanisms which cause radioinduced increase of the creep rate are discussed. These mechanisms include the formation of dislocation networks, point defects, and thermal spikes. Increase in diffusion speed, super-stoichiometric oxygen content, and amorphous phases within the brain boundary region also affect creep rate increases. (F.S.)

14415 (GAMD-5605) POST-IRRADIATION EXAMINATION OF THE GAIL III-B FUEL ELEMENT. Luby, C. S.; Shoemaker, H. E.; Tully, G. R. Jr. (Gulf General Atomic, Inc., San Diego, Calif.). Aug. 14, 1964. Contract AT(04-3)-167. 122p. Dep. CFSTI.

Post-irradiation examination of the Gail III-B fuel element is the basis for evaluating radioinduced dimensional changes in the fuel compacts. Efforts devoted to location of a leak in the purge

system, and determination of the extent and character of fission product migration are discussed. Coating failures were found to be proportional to both burnup and temperature. The condition of the sleeve graphite was excellent with no evidence of any erosion, chemical attack, cracks, or holes. Axial expansion was ≤1% and radial expansion was insignificant. Other observed expansion was due to hydrolysis of the carbide fuel particles on exposure to moisture. Fuel compacts exposed to moisture while under restraint expand only enough to fill the available void volume. When the restraint is removed, expansion continues. The in-pile observed leak was due to a crack in the weld at the base of the purge chamber. (F.S.)

14416 (GAMD-8428) SUMMARY OF GULF GENERAL ATOMIC COATED PARTICLE IRRADIATION EXPERIMENTS CONDUCTED ON THE HTGR-BASE PROGRAM. Luby, C. S. (Gulf General Atomic, Inc., San Diego, Calif.). Dec. 22, 1967. Contract AT(04-3)-167. 14p. Dep. CFSTI.

Summary tables are given which contain information on coated particle experiments in the HTGR-Base Program. The tables include descriptions of the samples tested, irradiation conditions, results of post-irradiation examination, and analytical parameter which comprise the current Gulf General Atomic model of coated particle irradiation performance. The tables contain the best available data as of October 1967 and they are subject to revision. (F.S.)

14417 (GAMD-8429) SUMMARY OF GULF GENERAL ATOMIC COATED PARTICLE IRRADIATION EXPERIMENTS CONDUCTED ON THE PSC PROGRAM. Luby, C. S. (Gulf General Atomic, Inc., San Diego, Calif.). Dec. 22, 1967. Contract AT(04-3)-633. 8p. Dep. CFSTI.

Summary tables containing information on coated particle irradiation experiments for the Public Service of Colorado program are given. The tables include descriptions of the samples tested, irradiation conditions, results of post-irradiation examination, and analytical parameters which comprise the current Gulf General Atomic model of coated particle irradiation performance. The tables contain the best available data as of October 1967 and are subject to revision. (F.S.)

14418 (N-68-35826) OPTICAL ABSORPTION AND FLUORESCENCE IN FUSED SILICA DURING TRIGA PULSE IRRADIATION. Gagosz, R.; Waters, J. (United Aircraft Corp., East Hartford, Conn.). (NASA-CR-1191; G-910485-3).

An experimental investigation was conducted at the Mark II pulse reactor to determine the spectral transmission characteristics during and after an irradiation pulse and to determine the cause of the apparent increase in transmission during the pulse and the apparent decrease of transmission after the pulse which had been observed in the previous test program. A total of 91 experiments were performed on six specimens at 500 to 900°C. Transmission measurements were made at two wavelengths, 2150 and 3021 Å. Corning 7940 fused silica specimens in a corner cube configuration were mounted next to the reactor core face at the internal end of a reactor beam port. Peak neutron and gamma fluxes obtained from this reactor were approximately 5 to 4×10^{15} n/cm²-sec and 6.1×10^{7} R/sec, respectively. Neutron and gamma doses associated with these pulses were 2.3×10^{-14} n/cm² and 2.0×10^{6} R, respectively. In addition to the transmittance tests, bypass and optical instrumentation tests were conducted to examine the influence of the optical alignment parameters upon system operation. Fluorescent tests were also conducted to obtain an applicable correction to the transmittance runs. (auth) (STAR)

14419 RADIOLYTIC OXIDATION OF SINGLE CRYSTAL GRAPHITE. NATURE OF ACTIVE SPECIES AND G VALUES. Feates, F. S. (Atomic Energy Research Establishment, Harwell, Eng. Argonne National Lab., Ill.). Trans. Faraday Soc., 65: 211-18(Jan. 1969).

Two processes are involved in the gasification of graphite by γ radiation. Species, tentatively identified as ground-state-oxygen atoms in O_2 and CO_3 in CO_2, leave vacancies in basal planes, which are subsequently expanded by the reaction of mobile surface oxides. The surface oxides may be generated from gaseous ions. G(vacancy formation) in oxygen and CO_2 is about 4×10^{-3} and G(–C) is 1.45 in CO_2 and 5.1 in O_2. The transient changes in oxidation rate at the beginning of reaction are analyzed, and s[illegible] results are shown to be consistent with work on bulk graphite. (auth) (UK)

14420 THERMOELECTRIC POWER AND INTERNAL FRICTION OF SOME GRAPHITIC CARBONS. Taylor. R. E.; Kline, D. E. (Pennsylvania State Univ., University Park). Tanso, No. 54, 99-101(Aug. 1968).

Studies were made to determine the relation between internal friction and thermoelectric power in various graphite carbons, and changes in the properties resulting from annealing and neutron irradiation. No overall relation was observed. Low temperature annealing of the machined samples significantly reduced internal friction, but did not change the thermoelectric power. Low-dose irradiation produced complex changes in internal fraction-temperature relations; the general level of thermoelectric power was changed somewhat in the positive direction. Stress-graphitizing as-deposited PC markedly changed both the internal friction and thermoelectric power. (NSA of Japan)

14421 VARIATION OF THE ELECTRIC CONDUCTIVITY OF UO_2 UNDER THE EFFECT OF A NEUTRON FLUX. Debiesse, Jean; Klein, Siegfried; Sorriaux, Andre; Lipskier, Marcel (Institut National des Sciences et Techniques Nucleaires, Gif-sur-Yvette, France). Compt. Rend., Ser. A and B, 267: 469-72(Aug. 19, 1968). (In French).

It is shown that the creation of electric charges by the fission reaction in a UO_2 sample causes a variation of its electric conductivity. In the interval of measurements made, up to 10^{11} n/cm²/sec, this variation which should be linear is perturbed by a temperature increase of several tens of degrees. A relative variation $\Delta\rho/\rho$ of the order of 0.1% was observed. It is a relatively important effect, subject to application. (tr-auth)

Plastics and Other Materials

Refer also to abstracts 15600 and 15673.

14422 (LA-4060) SPECIALIZED HIGH-PERFORMANCE COATINGS. Newfield, S. E.; Eaton, E. E.; Ehart, E. P. (Los Alamos Scientific Lab., N. Mex.). Nov. 1, 1968. Contract W-7405-eng-36. 8p. Dep. CFSTI.

Several specialized coatings have been used where good performance is required under extreme conditions, including cryogenic and elevated temperatures, corrosive environments, wear, friction, and radiation. Successful applications of various commercial and locally-formulated coatings are discussed. (auth)

14423 RADIATION RESISTANT INSULATION. Brechna, Habib (to United States Atomic Energy Commission). U. S. Patent 3,427,189. Feb. 11, 1969.

A high voltage insulation is described that is resistant to deterioration when subjected simultaneously to high levels of nuclear radiation, high temperatures, and large mechanical stresses. It consists of fiberglas cloth uniformly impregnated with a thermosetting organic resin impregnant, such as an epoxy, polyester, or silicone resin, in which a large proportion of inorganic filler material, such as aluminum oxide, ground glass or mica, is suspended prior to impregnation of the cloth. (AEC)

PHYSICS (GENERAL)

Astrophysics and Cosmology

Cosmic Ray Exposure Ages

Refer to abstract 14653.

Stars

Refer also to abstracts 14508, 14828, and 15430.

14424 FINE-STRUCTURE TRANSITIONS. Bahcall, John N. (California Inst. of Tech., Pasadena); Wolf, Richard A. Astrophys. J., 152: 701-29(June 1968).

Collision cross-sections and photon transition probabilities were calculated for many cases of practical interest. Using the calculated rates, it is shown how the fine structure of absorption lines can be used as an indicator of the density of the absorbing medium or the ambient intensity of a strong photon flux. For densities much greater than a critical value, N_{cr}, or for very high photon fluxes, the fine-structure levels of the ground of a given ion are populated according to a Boltzmann distribution (which for most practical cases means according to the ratio of degeneracies). For densities much less than N_{cr} and moderate photon fluxes, only the lowest fine structure state is populated. The value of N_{cr} is calculated for the most abundant ions that have resonant absorption lines with wavelengths greater than 950 Å by evaluating the rates of the photon and collisional transitions among the fine structure levels. Cross sections for collisional excitation by protons were calculated by numerical integration of the relevant time-dependent Schroedinger equation for six ions of interest and these detailed calculations were used to obtain accurate estimates of the proton-excitation cross sections for a number of other cases. The probability of exciting fine-structure levels of both neutral and charged ions by collisions with hydrogen atoms was estimated. The rates of magnetic-dipole photon decays, as well as cross sections for collisional excitation of fine-structure levels by electrons, were calculated from previously published results. Applications are made to problems involving the interstellar medium, circumstellar envelopes of giant stars, the solar corona, planetary nebulae, the intergalactic medium, and quasi-stellar sources. (auth)

14425 ON THE POSSIBILITY OF THE REDDENING OF MU CEPHEI BY CORE–MANTLE GRAINS. Svatos, J. (Charles Univ., Prague). Bull. Astron. Inst. Czech., 19: 239-41(1968).

It is shown that the most probable parameters of the core–mantle particles which can produce the observed reddening of μ Cep are: $R_g = 0.25\mu$, $R = 0.40\mu$, refractive index = 1.2 or 1.33. The results are obtained by means of intensity measurements with the Stratoscope II compared with the computed models of corresponding efficiency factors Q_{ext} and Q_{scat}. (auth)

14426 RECTIFIED ELLIPSOID–ELLIPSOID MODEL. Horak, T. (Military Academy, Brno). Bull. Astron. Inst. Czech., 19: 241-8(1968).

An extension of the iterative minimization method of calculating the elements of a close binary on the electronic computer is presented. The obtained ellipsoid–ellipsoid elements of TZ CrA differ in blue and yellow colors in the lengths of the semi-axes a_1, c_1, and a_2. The ellipticity coefficients and the Fourier coefficients of the lights outside eclipse are given. (auth)

14427 EVOLUTION OF CLOSE BINARIES. II. ON THE ONDREJOV COMPUTING PROGRAM. Kriz, S. (Czechoslovak Academy of Sciences, Ondrejov). Bull. Astron. Inst. Czech., 19: 248-53(1968).

Two methods are devised for obtaining the time sequence of evolutionary models of the component star of a binary system in the phase of mass transfer. The numerical solution directly incorporates the additional boundary condition, namely, that the star's radius is equal to the radius of the Roche limit. In addition, procedures are described for computing the time change of chemical composition in a convective core, and for integrating the outer layers. (auth)

14428 ENERGY LOSSES DUE TO NEUTRINO EMISSION IN ADVANCED STAGES OF STELLAR EVOLUTION. Dallaporta, N. (Univ., Padua). Nuovo Cim., Suppl., 6: 827-34(1968).

In considering the energy losses due to neutrino emission, only those production processes are considered which could be termed pathological ones and are supposed to occur according to some hypothetical reactions produced by weak interaction theories. It is tentatively concluded that at the present there is no particular astrophysical requirement for the existence of neutrino Feynman processes in stars. (J.F.P.)

14429 A SEARCH FOR LITHIUM AND BERYLLIUM IN Ib SUPERGIANTS AND CEPHEIDS. Conti, Peter S. (Univ. of California, Berkeley); Wallerstein, George. Astrophys. J., 155: 11-15(Jan. 1969).

A survey of thirty-one stars of types F and G, luminosity class Ib, and twenty Cepheid variables for the neutral-lithium line at 6707 Å was completed and a search was made for the resonance lines of ionized beryllium in six similar stars. No positive identification of lithium or beryllium could be made in any of the stars. Upper limits on the lithium and beryllium abundances are listed for all program stars. The lithium content of F and G Ib stars and Cepheids is less than in young, main-sequence F stars by factors of at least 10 to 100. For beryllium the deficiency factors are 3 to 10. The interpretation is that the more massive stars (5 to 9 $M_\odot$) that evolve to become F-G Ib stars contract to the main sequence so rapidly that they do not have sufficient time to produce lithium and beryllium by surface activity. It is also possible that all the stars observed have already reached the red-giant stage at least once in their evolution and hence diluted their atmospheres with material that had been depleted of lithium and beryllium by nuclear burning. (auth)

14430 EFFECT OF SILICON OPACITY ON B- AND A-STAR ATMOSPHERES. Strom, S. E.; Strom, K. M. (Smithsonian Astrophysical Observatory, Cambridge, Mass.). Astrophys. J., 155: 17-26(Jan. 1969).

The opacity arising from bound-free transitions for neutral silicon is found to have a significant influence on the emergent fluxes and hydrogen-line profiles for A and late B stars. By ignoring the silicon opacity, effective temperatures and surface gravities are overestimated for silicon-rich stars with $T_{eff} \gtrsim 10{,}000°K$; for cooler stars the surface gravities are also overestimated. Some simplifications in the discussion of the silicon-rich Ap stars are suggested as a consequence of these results. (auth)

14431 LYMAN-LINE DECREMENTS IN LOW-DENSITY PLANETARY NEBULAE. Walmsley, C. M.; Mathews, W. G. (Univ. of California, San Diego). Astrophys. J., 155: 57-66 (Jan. 1969).

The radiation fields of Lyman-α to Lyman-10 were calculated for two model planetary nebulae having constant and exponential density distributions in spherical symmetry. The decrement for the higher lines is very flat. Both the decrement and the photon density distribution of the lines are shown to be rather insensitive to the density distribution. An attempt is made to understand these results in terms of elementary arguments. Observations of the Lyman lines in planetary nebulae will provide information about neutral gas at high galactic latitudes and determine the integrated photon luminosity of the central star in the Lyman continuum. (auth)

14432 610.5 MHz CONTOUR MAPS OF THE SUPERNOVA REMNANTS HB 9, SIMEIS 147, AND IC 443. Dickel, John R.; McKinley, Raymond R. (Univ. of Illinois Observatory, Urbana). Astrophys. J., 155: 67-73(Jan. 1969).

Contour maps of the supernova remnants HB 9, Simeis 147, and IC 443 were made at 610.5 MHz with a resolution of 16′ by using the 122-meter telescope at the University of Illinois. The integrated flux densities of these remnants are 157 ± 26, 148 ± 60, and 215 ± 32 flux units, respectively. The spectra of all three sources show that the radiation is probably nonthermal, and the general features are those of old supernova remnants. (auth)

14433 HIGH-LEVEL POPULATIONS OF HYDROGEN IN GASEOUS NEBULAE. Dyson, J. E. (Univ. of Wisconsin, Madison). Astrophys. J., 155: 47-56(Jan. 1969).

Factors b_n and $d \ln b_n / dn$ were computed for the high levels of hydrogen in gaseous nebulae. A density range of 10 to 10^5 electrons cm^{-3} is covered at electron temperatures of 5×10^3°, 10^4°, and 2×10^4°K. The computations differ from those made previously by the inclusion of collisional excitation and de-excitation in which the principal quantum number changes by more than unity. The factors were also computed by taking into account radiative transitions between levels induced by the free–free continuum within the nebula. For any reasonable emission measure, the effects of

these transitions on the level populations are completely negligible. (auth)

14434 STRONG COLLISIONS IN HYDROGENIC LINE BROADENING. Shen, K. Y.; Cooper, J. (Joint Inst. for Lab. Astrophysics, Boulder, Colo.). Astrophys. J., 155: 37-45 (Jan. 1969).

The degeneracy of hydrogenic states was used to sum approximately the S-matrix to all orders in Stark-broadening calculations. It was found that the usual strong-collision cutoff for lower lines should represent a reasonable approximation. However, there could be a significant difference between the results and previous calculations for transitions among levels with large principal quantum numbers. (auth)

14435 ADIABATIC FLUID SPHERES IN GENERAL RELATIVITY. II. MASSIVE CONFIGURATIONS OF IDEAL GAS AND RADIATION. Tooper, Robert F. (California Inst. of Tech., Pasadena). Astrophys. J., 155: 145-61 (Jan. 1969).

General-relativistic models of massive hot nonrotating stars with adiabatic temperature gradients are dealt with in this paper. The stars are assumed to consist of a mixture of ideal gas and radiation at a finite temperature T, and the models therefore form a two-parameter family of solutions to the equations of hydrostatic equilibrium in general relativity. The parameters characterizing a particular member of the sequence are the ratio α of pressure to rest energy density at the center, and the central value (denoted by y_c) of the ratio of radiation pressure to gas pressure. Results are presented as contours, in the space of these two parameters, of central temperature, rest mass, active gravitational mass, radius, binding energy, and period of linearized adiabatic radial oscillations. For each subsequence of models with constant rest mass, the onset of dynamical instability is found to occur at the point where the binding energy, considered as a function of α, has its first relative maximum. A class of general-relativistic models, with masses $<10^4$ $M_\odot$, stable according to the assumptions about the equation of state, but with central temperatures high enough to cause electron–positron pair formation, is shown to exist. The desirability of examining in detail the effects of pair formation on the structure and stability of these models is indicated. (auth)

14436 NON-RADIAL PULSATION OF GENERAL-RELATIVISTIC STELLAR MODELS. II. PROPERTIES OF THE GRAVITATIONAL WAVES. Price, Richard (California Inst. of Tech., Pasadena); Thorne, Kip S. Astrophys. J., 155: 163-82 (Jan. 1969).

An analysis is presented of the properties of the gravitational waves emitted by a fully relativistic, nonrotating stellar model, which is pulsating in a nonradial manner. Attention is focused on quasi-normal-mode pulsations in which the star is excited at some initial moment of time, it radiates gravitational waves thereafter, and these waves gradually damp its nearly periodic pulsations. For such quasi-normal modes a discussion is presented of the polarization of the gravitational waves and of the energy, momentum, and angular momentum which the waves transport. (auth)

14437 MODELS FOR CARBON-RICH STARS. Beaudet, G.; Salpeter, E. E. (Cornell Univ., Ithaca, N. Y.). Astrophys. J., 155: 203-19 (Jan. 1969).

Models for carbon-rich stars (with an initial homogeneous composition of 50% ^{12}C and 50% ^{16}O by mass) below the Chandrasekhar limiting mass are presented. Two series of models are presented; one with the newest rates for neutrino-pair energy losses and one without any neutrinos. The minimum mass M_{min} for carbon burning is 0.78 $M_\odot$ without and 0.97 $M_\odot$ with the neutrino energy losses, if previously published carbon-burning rates are used. Decreasing this rate by a factor 40, increases M_{min} from 0.97 $M_\odot$ to 1.06 $M_\odot$. In the presence of neutrinos, carbon burning starts in a shell for the smaller masses, and the star experiences a fairly large carbon flash, similar to the helium flash. Some inhomogeneous models, containing a helium envelope, are also presented, and the maximum mass fraction q_l for a nonburning helium envelope is found. The increase in radius due to a small hydrogen outer envelope is then calculated. The relevance of the models to the central stars of planetary nebulae and to very hot white dwarfs is discussed. (auth)

14438 NUCLEAR REACTION RATES AT HIGH DENSITIES. Salpeter, E. E.; Van Horn, H. M. (Cornell Univ., Ithaca, N. Y.). Astrophys. J., 155: 183-202 (Jan. 1969).

General expressions were calculated which are suitable for use in numerical stellar-interior calculations for nuclear reaction rates. The density–temperature combinations which are called the weak-screening, strong-screening, and pycnonuclear regimes were considered. Except in the pycnonuclear case the results are expressed in the form of "correction factors" with which one multiplies the ordinary thermo-nuclear reaction rate evaluated at the same temperature and density. By considering the extreme cases of $Z_1 = Z_2$ and $Z_1 \gg Z_2$, where Z_1 and Z_2 are the atomic numbers of the two reacting nuclei, interpolation formulae which are valid for any ratio of charges Z_1/Z_2 throughout the entire weak- and strong-screening regimes were devised. Strong-screening corrections to resonant nuclear reaction rates are discussed and an explicit formula for the important special case of the triple-alpha reaction is given. Finally, by applying the results to the case of the proton chain, it is shown that the hydrogen abundance in the white dwarf Sirius B must be less than 3.5×10^{-5}. (auth)

14439 LATE PHASES OF STELLAR EVOLUTION. I. PURE IRON STARS. Savedoff, M. P.; Van Horn, H. M.; Vila, S. C. (Univ. of Rochester, N. Y.). Astrophys. J., 155: 221-45 (Jan. 1969).

The effect of neutrino loss on the evolution of pure iron stars of 0.398, 0.631, 1.0, and 2.5 $M_\odot$ is studied. The evolutionary tracks, computed by the Henyey–Schwarzschild method, are followed into the white-dwarf stage, in the case of those models less massive than the Chandrasekhar limit, or to the stage of incipient stability in the case of the presupernova models. Comparison with other models for similar evolutionary phases enables one to identify some of the physical processes of importance for these late stages and to suggest the following conclusions: (1) the 1 $M_\odot$ models with neutrino losses follow an evolutionary path resembling the one suggested by Harmon and Seaton for the nuclei of the planetary nebulae and are also consistent with the time scale of ~10,000 years suggested for these stars; (2) the iron–helium transition may not be the mechanism responsible for the core collapse in presupernovae of mass ~2.5 $M_\odot$. (auth)

14440 PULSATIONAL INSTABILITIES IN HYDROGEN-POOR MASSIVE BLUE STARS. I. Simon, Norman R.; Stothers, Richard (Goddard Space Flight Center, New York). Astrophys. J., 155: 247-55 (Jan. 1969).

The structure and pulsational properties of massive stars with helium cores and thin, hydrogen-poor envelopes were investigated. The core structures are very insensitive to modifications of the hydrogen envelope. However, it is found that the total stellar radius and luminosity are modified by the integrated hydrogen content and by the hydrogen gradient, respectively. The models are pulsationally stable under modest conditions of central condensation (due to a hydrogen-burning shell and/or high hydrogen content). The unstable models are energized almost entirely by the helium reactions in the core, while most of the damping occurs in the thin hydrogen envelope. For each mass, the period is remarkably insensitive to the envelope modifications. The critical models dividing stable from unstable models are determined by (1) a pulsational eigenfrequency $\omega^2 \sim 3$ and (2) the size of the hydrogen gradient. The critical models explain some of the observed features of the classical Wolf–Rayet stars of high luminosity but seem to be too blue with respect to Rublev's sequence of stars on the H–R diagram. (auth)

14441 SLOWLY ROTATING CONVECTIVE MODELS WITH RADIATION PRESSURE. Sackmann, I. J.; Anand, S. P. S. (Univ. of Toronto, Richmond Hill, Ont.). Astrophys. J., 155: 257-64 (Jan. 1969).

Ten uniformly rotating models were constructed in the framework of a theory of first-order perturbation. They are in convective equilibrium and differ from earlier models in that the effects of radiation pressure are included. The models are characterized by the physical parameter y_c, which is the ratio of the central radiation pressure to the central gas pressure. The fractional changes due to rotation on the mass, the volume, and the ratio of central to mean density for all values of y_c are also obtained. The extreme models agree well with the standard rotating polytropes. (auth)

14442 ON THE ALBEDO PROBLEM FOR A FINITE PLANE-PARALLEL RAYLEIGH-SCATTERING ATMOSPHERE. Shieh, P. S.; Siewert, C. E. (North Carolina State Univ., Raleigh). Astrophys. J., 155: 265-71 (Jan. 1969).

The complete radiation field at any optical depth within a plane-parallel finite Rayleigh-scattering atmosphere is constructed, subject to generalized free-surface boundary conditions. The method of solution used here is based on Case's normal mode expansion technique and Chandrasekhar's results for the reflected and transmitted distributions. The various unknown expansion coefficients are shown to take quite simple forms when expressed in terms of the appropriate X- and Y-functions introduced by Chandrasekhar. (auth)

14443 THEORETICAL LINE INTENSITIES. VII. WAVELENGTH AND DEPTH DEPENDENCE OF LINE-BLANKETING EFFECTS FOR PURE ABSORPTION AND NON-COHERENT SCAT-

TERING. Athay, R. Grant; Skumanich, A. (High Altitude Observatory, Boulder, Colo.). Astrophys. J., 155: 273-94 (Jan. 1969).

The processes involved in line blanketing are investigated in detail for a two-level atom whose spectral line is formed partially in pure absorption and partially in noncoherent scattering (non-LTE). Line and continuum interactions are included through absorption of line photons by continuum processes, and vice versa. Interactions with the thermal energy of particles are included through collisional excitations and de-excitations. Calculations of the "local" blanketing effect, designated by e, are made for lines of different equivalent widths, in different spectral regions, and for different absorption profiles. An atmosphere in which $B(\tau)$ is linear is considered. In general, such an atmosphere is not in radiative equilibrium and requires mechanical energy to maintain the assumed temperature profile even if no lines are present in the spectrum. If lines are added to the spectrum without distorting $B(\tau)$, the local energy requirements are changed by an amount e and the total energy (per unit area) is changed by an amount $E = \int e d\tau$. For a Milne–Eddington (M–E) atmosphere in pure absorption (LTE) and linear $B(\tau)$, E is shown to be positive (mechanical energy must be added to the atmosphere) and equal to the flux "blocked" out by the equivalent widths of the lines, $\Sigma W_i H_i^c$. In the corresponding case for a Schuster–Schwarzschild (S–S) atmosphere, just the reverse is true, $E = -\Sigma W_i H_i^c$, and energy must be removed from the atmosphere to preserve the linear $B(\tau)$. In the limiting case of an isothermal atmosphere in LTE, $E \rightarrow -\Sigma W_i H_i^c \rightarrow 0$ for the M–E atmosphere. When scattering (non-LTE) is present for a M–E atmosphere E is the same as for LTE for saturated lines in all spectral regions, while it is approximately the same for unsaturated lines in the violet and visual spectral regions. In the case of the S–S atmosphere, the LTE result for the integrated blanketing remains unchanged. However, in both cases the local LTE and non-LTE blanketing effects as given by e differ appreciably, mainly in the degree of thermal cooling at the boundary. Equations derived to express the self-consistent (radiative equilibrium) problem provide more accurate and numerically more tractable calculations of the blanketed temperature profile. (auth)

14444 THE EFFECT OF LYMAN-ALPHA WING OPACITY ON THE TEMPERATURE SCALE AND HELIUM CONTENT FOR SUBDWARFS. Strom, S. E.; Strom, K. M. (Smithsonian Astrophysical Observatory, Cambridge, Mass. Harvard College Observatory, Cambridge, Mass.). Astrophys. J., 155: 363-5 (Jan. 1969).

The wings of Lyman alpha are shown to be an important source of opacity in F and G subdwarf atmospheres. Previous estimates of T_{eff} based on stellar-atmosphere calculations that ignore this opacity are found to be too small by 100 to 200°K. This change in the T_{eff} scale for subdwarfs strengthens the argument that the helium content of the extreme subdwarfs cannot be very low. (auth)

14445 THE [O III] TEMPERATURE FOR ONE "FILAMENT" IN THE CYGNUS LOOP. Parker, Robert A. R. (Univ. of Wisconsin, Madison. NASA Manned Spacecraft Center, Houston, Tex.). Astrophys. J., 155: 359-61 (Jan. 1969).

New observations indicate that a range of temperatures exists within individual "filaments" of the Cygnus Loop. This is in general agreement with the stratified models that have been proposed for these "filaments." (auth)

14446 SPECTRAL LINE INTENSITY VARIATIONS IN PLANETARY NEBULAE. Aller, L. H. (Commonwealth Scientific and Industrial Research Organization, Sydney); Wares, G. Nature (London), 221: 646 (Feb. 15, 1969).

It has been suggested that the small southern planetary nebula IC 4642 shows striking spectral changes. The present authors made photographic spectrophotometric measurements of a number of southern planetaries, including IC 4642, using the 60 inch reflector at Cerro Tololo in Chile. Measured line intensities are tabulated for the spectrum of IC 4642, and the spectrum in the region λ 3727 is shown graphically. The authors state that on the basis of available observations they were not convinced that spectral changes have actually occurred in IC 4642; further careful studies are needed for this object, which is one of the highest excitation planetaries known. (UK)

14447 OBSERVATIONS OF 28 HYDROGEN nα LINES FROM THE ORION NEBULA. Menon, T. K. (Univ. of Hawaii, Honolulu); Payne, J. Astrophys. Lett., 3: 25-7 (Jan. 1969).

The electron temperature of the Orion Nebula is estimated to be about 6750°K from the intestines of 28 hydrogen nα lines in the frequency range 1 to 2 GHz. The detailed measurement of the 164 α line failed to show any effect of Stark broadening in the amount predicted by the theory of Griem (1967). (auth)

14448 INSTABILITY OF STELLAR STRUCTURES INTERMEDIATE BETWEEN WHITE DWARFS AND NEUTRON STARS. Cameron, A. G. W. (Yeshiva Univ., New York. Goddard Inst. for Space Studies, New York); Cohen, J. M. Astrophys. Lett., 3: 3-6 (Jan. 1969).

Drake has suggested that apparent multi-millisecond periodicities in pulsar signals may correspond to vibrations of neutron stars. Stellar models in the appropriate density range (of the order of 10^{13} gm/cm^3) with an improved equation of state were re-examined and it is concluded that suitable stable structures, intermediate between white dwarfs and neutron stars, are unlikely. (auth)

14449 AN EXTREMELY RED STAR IN THE REGION OF THE YOUNG OPEN CLUSTER NGC 6231. Seggewiss, Wilhelm (Univ., Bonn). Astrophys. J., 155: L1 (Jan. 1969).

In connection with a photometric study of the open cluster NGC 6231, which constitutes the nucleus of the association Sco OB1, a very red star was found. The color index, color excesses, and absolute magnitudes of the star are given. (W.D.M.)

14450 CIRCUMSTELLAR INFRARED EMISSION FROM TWO PECULIAR OBJECTS: R AQUARII AND R CORONAE BOREALIS. Stein, Wayne A. (Univ. of California, San Diego. Univ. of Minnesota, Minneapolis); Gaustad, John E.; Gillett, F. C.; Knacke, R. F. Astrophys. J., 155: L3-7 (Jan. 1969).

Observations were made at wavelengths from 2.8 to 14 μ of the carbon-rich peculiar variable R Coronae Borealis and the M7 variable associated with an emission nebula R Aquarii. It was found that both of these objects show fluxes of infrared emission greater than the fluxes expected from the stars alone. These infrared excesses are attributed to circumstellar matter. The results are compared with the excess infrared radiation from cool stars and the infrared from the planetary nebula NGC 7027 that have been observed in earlier work. (auth)

14451 CHANGES IN POLARIZATION OF THE R CORONAE BOREALIS STAR RY SAGITTARII. Serkowski, K. (Australian National Univ., Canberra); Kruszewski, A. Astrophys. J., 155: L15-16 (Jan. 1969).

During the minimum of RY Sagittarii the percentage polarization increased from 0.5 to at least 1.3% and the position angle changed from about 10 to 150°. (auth)

14452 PROBABLE DETECTION OF INTERSTELLAR $^{13}CH^+$. Bortolot, V. J. Jr. (Columbia Univ., N. Y.); Thaddeus, P. Astrophys. J., 155: L17-20 (Jan. 1969).

A new interstellar line has been found in the spectrum of ζ Oph at 4232.08 ± 0.01 Å, which is probably the R(0) (0,0) A $^1\Pi - X\ ^1\Sigma$ line of $^{13}CH^+$. The equivalent width of this line is measured to be W = 0.68 ± 0.14 mÅ. Together with the neighboring strong line of the normal isotopic species, this yields for the isotopic abundance ratio in the line of sight $[^{12}C]/[^{13}C] = 82\ (+55, -15)$. (auth)

14453 SPECTRUM OF PROTONS ACCELERATED AT THE SURFACE OF THE STARS AS DEDUCED FROM LITHIUM AND BERYLLIUM OBSERVATIONS. Reeves, H.; Audouze, J. Bull. Inform. Sci. Tech. (Paris), No. 131, 29-33 (Nov. 1968). (In French).

Recent determinations of ^6Li, ^7Li, and ^9Be abundances in main-sequence stars, together with recent determinations of nuclear formation and destruction cross sections of these elements, were used to obtain some information on the mean spectrum of accelerated particles in stars. A spectrum of the form $\varphi(E)\, dE\ \alpha\ E^{-\gamma} dE$ with $\gamma = 2.5$ to 3 appears to meet the various requirements discussed. (auth)

14454 DETECTION OF THE 12.8-MICRON Ne^+ EMISSION LINE FROM THE PLANETARY NEBULA IC 418. Gillett, F. C. (Univ. of California, San Diego. Kitt Peak National Observatory, Tucson, Ariz.); Stein, W. A. Astrophys. J., 155: L97-100 (Feb. 1969).

Observations of the planetary nebula IC 418 were made with an infrared spectrometer having a resolution $\Delta\lambda/\lambda \approx 0.013$. A flux from this object was detected at 12.8 μ, the wavelength of an expected emission line of Ne^+. In addition, it appears that a continuum was also detected similar to that observed from NGC 7027, although with low statistical accuracy. (auth)

14455 NARROW-BAND PHOTOMETRY OF FIVE COMBINATION-VARIABLE STARS AND THE X-RAY SOURCE CYG X-2. Johnson, H. M. (Lockheed Missiles and Space Co., Palo Alto, Calif.); Golson, J. C. Astrophys. J., 155: L91-6 (Feb. 1969).

HD 4174, AG Dra, AG Peg, MHa 328-116, CH Cyg, and Cyg X-2 were observed in narrow bands around Hβ and in a narrow band which includes He II λ4686 and N III λ4640 when they are present.

Some of these previously active stars were quiet on the dates of the work. But the light curves of CH Cyg suggest eclipses in Hβ and in the continuum as well as small flares in the continuum. The light curves of Cyg X-2 show that He II λ4686 weakens as Hβ absorption increases on one date, while independent variation of the continuum occurs from one date to the next. There is no common pattern of variability in these stars. (auth)

14456 OUR UNIVERSE: THE KNOWN AND THE UNKNOWN. Wheeler, John Archibald (Princeton Univ., N. J.). Amer. Sch., 37: 248-74(Spring 1968).

The collapse of a star as related to the expansion and recontraction of the Universe is discussed with respect to Einstein's theory of geometrodynamics. Two kinds of collapses are expected in stars that have slowly developed in the course of time to an overdense state. In one type of event, where the core exceeds the critical mass, the collapse goes to completion, and little if anything is seen. In the other kind of collapse the core, endowed with a less than critical mass, ends as a neutron star thus producing a supernova. Properties of a collapsed star, or "black hole," are discussed. Measurement of its size is studied. The diameter of the black hole is defined as of the order of 10 km, the precise value depending on the mass of the core that underwent collapse. Many stars have invisible companions, revealed only by motion of the visible component. In some cases the mass is comparable to the mass of the Sun, and could be compatible with interpretation as a black hole or as a neutron star. Many visible stars eject matter and some of this matter, falling on a neutron star, will hit with such an impact as to generate x rays in substantial quantity. Correlations between x-ray sources and binaries in which one component is invisible are being sought. The 1965 London International Conference on Gravitation Physics discussions of gravitational collapse are noted. The predictions of quantum geometrodynamics are outlined. Indeterminism is related to stellar collapse, so that alternate histories of the star are coupled at collapse. (BBB)

14457 STELLAR SYMBIOSIS. Zahn, Jean-Paul (Observatoire, Nice). Atomes (Paris), 23: 422-7(July-Aug. 1968). (In French).

Close pairs have been known since the observations of Montanari on Algol in 1669. The origin of the periodicity of brightness has been taken as the presence of a dark companion whose existence cannot be distinguished by low-resolving telescopes, and analysis of the data allows calculation of the mechanics of interaction either by stellar parallax methods or by displacement of the spectral lines. The origin of such species is discussed: fragmentation of a cloud into nonequilibrium fragments, protostars. Condensation of these objects occurs without opposing force, and when hydrostatic equilibrium is achieved the objects become stars. The formation of a double star differs; it must be distinguished from the single star route at the Hayashi stage, perhaps by fission of a single star made unstable by rapid rotation. Material is lost at the equator, but possibly profound interior disturbances give rise to close pairs. Better understanding of such phenomena may lead to an understanding of novae, metallic stars, Wolf–Rayet stars, symbiotic stars, and other phenomena of stellar evolution. (BBB)

14458 RELATIVE PROTON NUMBER IN NEUTRON STAR MATTER. Nemeth, J. (Eotvos Univ., Budapest); Sprung, Donald W. L. Phys. Rev., 176: 1496-1500(Dec. 25, 1968).

The energy density of neutron star matter is determined from Brueckner-theory calculations of nuclear matter and the pure neutron gas. Three-body clusters are assumed to contribute negligibly to the nuclear energy, according to the theory of Bethe. The relative density of protons, determined by minimizing the total energy, is found to increase with increasing matter density. In addition, we find that muons would appear at about half the normal nuclear density. (auth)

14459 PULSATIONAL PROPERTIES OF A MASSIVE STAR IN THE HELIUM-BURNING PHASE. II. Prasad, C.; Mohan, C. (Univ. of Roorkee, India). Mon. Notic. Roy. Astron. Soc., 142: 151-60(1969).

Anharmonic pulsations of a star of 15.6 solar masses in the helium-burning phase of its evolution were studied. The effects of including (i) different numbers of higher modes in the anharmonic equations, (ii) radiation pressure in calculating the coefficients of the anharmonic equations, (iii) third-order terms in the anharmonic equations, and (iv) variation of the magnitude of the relative amplitude of pulsation, on the radial velocity curve of the stellar model were also investigated. (auth) (UK)

14460 THE INFLUENCE OF LINE BLANKETING UPON THE COLOURS OF CEPHEIDS AND F–K SUPERGIANTS. Bell, R. A. (Univ. of Maryland, College Park); Rodgers, A. W. Mon. Notic. Roy. Astron. Soc., 142: 161-99(1969).

A method is described for computing the line spectrum of an F–K supergiant or cepheid over a spectral range of several hundred Angstroms with high resolution. The method requires observational data on the spectrum of one such standard star, whence spectra of other stars may subsequently be generated by differential curve of growth techniques. Observed and computed spectra are compared for α Per (F51b), δ C Ma (F81a), and two phases of 1 Car. Computed spectra are then used to study the influence of line absorption upon narrow- and broad-band colors of supergiants and cepheids. It is found that the change in B–V of a cepheid with phase is caused partially by a change in temperature and partially by a change in electron pressure. The influence of metal abundance, microturbulent velocity, and electron pressure on B–V is examined in order to interpret the marked blueness of the Small Magellanic Cloud cepheids. It is found that only by the inclusion of all these effects, all acting in the same sense, can this blueness be explained. The influence of CN absorption upon the narrow band photometric index n of Griffin and Redman (196φ) is examined and it is found that the observed scatter in this index at a given spectral type may be explained by the CN abundance varying by a factor of three. Such variations are interpreted as being caused by the variation of the partial pressure of CN in stars of different masses. Satisfactory agreement with observations is obtained in calculations of the variation of other narrow band indices with spectral type using appropriate CH and CN abundances. The abundance of cerium in the solar atmosphere and the identification of ionized cerium lines in the solar spectrum are also considered. (auth) (UK)

14461 THE ψ-METHOD APPLIED TO BOTH MINIMA OF AN ECLIPSING BINARY. Cohen, Howard L. (Indiana Univ., Bloomington). Publ. Astron. Soc. Pac., 81: No. 478, 60-4(Feb. 1969).

A relatively simple method of applying Russell's ψ-method to the combined data of both minima is described. This method is suitable for use on an electronic computer. A procedure for use with complete eclipses is outlined, although it can be extended to partial eclipses. (auth)

14462 AN ABUNDANCE ANALYSIS OF THE B3 STAR HD 37058. Sievers, Helen Claire (Brigham Young Univ., Provo, Utah). Publ. Astron. Soc. Pac., 81: No. 478, 33-45(Feb. 1969).

An abundance analysis was made of the B3 V star HD 37058 using Wrubel's curve of growth. The two striking results of the study are that titanium is overabundant by a factor of about 220 and strontium by 17,000. These anomalies, together with the presence of a strong magnetic field, suggest that the star is a B-type counterpart of the peculiar A stars. (auth)

14463 STARS NEARER THAN FIVE PARSECS. Van de Kamp, Peter (Swarthmore Coll., Pa.). Publ. Astron. Soc. Pac., 81: No. 478, 5-10(Feb. 1969).

A list of stars is given which is a revision of the list (Van de Kamp 1953) published in 1953. Stars with parallaxes of 0″.192 and larger are included ie., up to a distance of 5.2 parsecs, or 17 light years. Luyten 1159–16 and Stein 2051 are newcomers to the list. Altogether there are 44 objects, of which 31 appear to be single, eleven double, and two triple. (W.D.M.)

14464 THE INTRINSIC COLOR INDEX AND ABSOLUTE MAGNITUDE OF POLARIS. McNamara, D. H. (Brigham Young Univ., Provo, Utah). Publ. Astron. Soc. Pac., 81: No. 478, 68-70(Feb. 1969).

New BV, uvby, and β photometry of α UMiB was carried out with a single-channel photometer attached to the 24-inch reflector at BYU. Great care was taken to eliminate the light of α UMiA from the diaphragm. The absolute magnitude of α UMiB was found to be $M_v = +3^m.0 \pm 0.2$ according to the calibration of M_v in terms of C_1 and (b–y) given by Strömgren (1963). Since the magnitude difference between α UMiA and B is $6^m.60$, the absolute magnitude of Polaris is $M_v = -3^m.6 \pm 0.2$ if the two stars form a physical system. (W.D.M.)

14465 A STUDY OF THE CLOSE BINARY STAR TU MONOCEROTIS. Kitamura, Masatoshi (Tokyo Univ.). Astrophys. Space Sci., 2: 448-60(Dec. 1968).

New photometric elements, $i = 89.5°$, $r_a = 0.24$, $r_b = 0.25$, and and $L_a = 0.82(Y), 0.88(B), 0.94(U)$, are deduced for the eclipsing system TU Mon, using the incomplete Fourier method for the analysis of its light curve. They are based upon three-color photoelectric observations obtained in 1966–68 with the 36-inch reflector of the Okayama Astrophysical Observatory. From discussion combined with the spectroscopic data by Deutsch (1945) and by Popper (1967), it seems fair to conclude that TU Mon is an ordinary semi-detached close binary system consisting of a detached brighter B5V star and an A5 subgiant in contact at its Roche limit. (auth)

14466 PARTIALLY DEGENERATE RELATIVISTIC ISOTHERMAL GAS SPHERES. Margrave, Thomas E. Jr. (George-

town Coll. Observatory, Washington, D. C.). Astrophys. Space Sci., 2: 504-9(Dec. 1968).

The problem of an isothermal gas sphere in which the pressure is supplied by partially degenerate relativistic electrons and radiation is examined. Numerical solutions for the cases ψ_0 = 0, 5, 10, and 20 are tabulated. (auth)

14467 MODELS OF RAPIDLY ROTATING WHITE DWARFS. Anand, S. P. S.; Dubas, Orest V. (Univ. of Toronto). Astrophys. Space Sci., 520-8(Dec. 1968).

Numerical solutions of the structural equations for rapidly rotating white dwarfs are tabulated for values of the central density parameter $y^{-\frac{2}{3}}$ ranging from 0.0001 to 0.80. The physical parameters of white dwarfs rotating at the breakup velocity are also tabulated. Further, the mass–radius relations for both the equatorial and the polar radii are derived. These two relations are found to differ from other recent theoretical calculations by less than 10 and 4%, respectively. The use of uniformly rotating white dwarf models to account for the observational data on Sirius B is discussed. It is concluded that Sirius B may be rotating rapidly and near its breakup velocity. Further, it is suggested that the radius and Einstein red shift for this star are 0.01135 $R_\odot$ and 59 km/sec. (auth)

14468 MOTIONS OF THE BRIGHT F-TYPE STARS. Eggen, O. J. (Australian National Univ., Canberra). Astrophys. J., 155: 701-7(Feb. 1969).

Space motions for 430 F-type stars with accurate apparent motions were computed from the parallaxes obtained from (uvby) photometry. The stars younger than the cluster NGC 752 confirm the domination, first noted from the motions of the A-type stars, of only a few stellar groups in the distribution of the (U, V) vectors of the motion. Nearly a third of the sample of F-type stars belong to the Hyades group. The motions of the stars older than NGC 752 are more randomly distributed and give median values of (U,V,W) = (+14,–15,–8) km sec^{-1}. A new stellar group, with (U,V) near (+28,–38), containing the δ Scuti variable ρ Pup and other F-type stars with an age near that of NGC 752, is also isolated. (auth)

14469 DYNAMICAL FRICTION IN THE POST-NEWTONIAN APPROXIMATION OF GENERAL RELATIVITY. Lee, Edward P. (Univ. of Chicago). Astrophys. J., 155: 687-95(Feb. 1969).

The dynamical friction acting on a star in a uniform isotropic system is computed. Encounters between stars are assumed to act independently, and their effects are computed in the post-Newtonian approximation of general relativity. (auth)

14470 COMPARISON OF SOME RECENTLY PROPOSED EXCITATION AND IONIZATION RATES. Sampson, Douglas H. (Pennsylvania State Univ., University Park). Astrophys. J., 155: 575-85(Feb. 1969).

A comparison of the collisional-excitation and -ionization rates used in statistical-equilibrium, model-atmosphere calculations by Mihalas is made with those used by Kalkofen and Strom. These rates are also compared with the earlier proposed rates of Seaton, van Regemorter, and Allen and rates recently proposed by Peterson based on the work of Burke, Ormonde, and Whitaker. The significance of differences in rates and assumptions of Mihalas and those of Kalkofen and Strom on calculated departures from LTE is discussed. Some apparent inconsistencies between suggested ionization and excitation rates are considered. (auth)

14471 CHEMICAL COMPOSITION OF THE LAMBDA BOOTIS STARS. Baschek, Bodo; Searle, Leonard (Australian National Lab., Canberra). Astrophys. J., 155: 537-53(Feb. 1969).

A curve-of-growth abundance analysis was carried out of λ Boo, 29 Cyg, π^1 Ori, θ Hya, and γ Aqr and of the comparison stars β Ari, ρ Peg, α Lyr, and HD 161817. It was found that only λ Boo, 29 Cyg, and π^1 Ori form a distinct group from the composition point of view. These stars are young main-sequence A stars of low turbulent velocities with metal deficiencies of a factor of ~3. Oxygen abundances are normal. In λ Boo itself, Ca and Mg are deficient with respect to iron. It is suggested that these stars constitute a type of Ap star and that their composition does not reflect that of the material from which they formed. (auth)

14472 ABUNDANCES IN TWO HORIZONTAL-BRANCH A STARS. Kodaira, K.; Greenstein, Jesse L.; Oke, J. B. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J., 155: 525-36(Feb. 1969).

Two horizontal-branch A stars, HD 86986 and HD 109995, were analyzed spectroscopically by a combination of coarse- and fine-analysis techniques with spectrophotometric scans. The physical parameters include space motions near 350 km sec^{-1}, effective temperatures near 7800°K, and low surface gravity, log g = 3.0. The rotational velocities are small. The stars were compared differentially with HD 161817, which was analyzed by Kodaira who used a model atmosphere. The metal deficiencies, with respect to the Sun, for all three stars are given. The mean values for thirteen elements were $\log_{10} \epsilon(*)/\epsilon(\odot) = -1.54$ (HD 86986), –1.76 (HD 109995), and –1.16 (HD 161817). The different nucleosynthetic processes show a systematic trend, similar to that found in the very metal-poor giant HD 122563. The α-nuclei (Mg, Ca, Si) are least deficient, the s-process (Sr, Y, Zr, Ba) most deficient, and the differences are largest in the most metal-poor star. An analysis of carbon and oxygen, using lines near the limit of detectability, shows them in high abundance, relative to the metals. (auth)

14473 EMISSION LINES IN THE ULTRAVIOLET SPECTRUM OF BOSS 1985. Swings, Jean Pierre (Univ. of Liege). Astrophys. J., 155: 515-23(Feb. 1969).

The emission lines in the ultraviolet spectrum (3144 to 3627 Å) of B1985 were identified and the effect of the excitation potential on the intensities of Fe II emission lines is discussed. (auth)

14474 THE ^{7}Be ELECTRON-CAPTURE RATE. Bahcall, John N.; Moeller, Charles P. (California Inst. of Tech., Pasadena). Astrophys. J., 155: 511-14(Feb. 1969).

The effect of plasma and bound-electron screening on the continuum capture rate of $^7Be(e^-,\nu)^7Li$ is calculated and shown to be negligible for situations in which the proton–proton chain is likely to be important. A more accurate expression for the continuum capture rate is then derived, making use of the numerical work of Bahcall and May (Astrophys. J., 155: 501(1969)). Convenient formulae are presented for use in stellar-model calculations. The average effect of bound-electron capture is also evaluated for several solar models. (auth)

14475 RATE OF THE PROTON–PROTON REACTION AND SOME RELATED REACTIONS. Bahcall, John N.; May, Robert M. (California Inst. of Tech., Pasadena). Astrophys. J., 155: 501-10(Feb. 1969).

The results of detailed calculations of the rate of the proton–proton reaction, $p + p \rightarrow {}^2D + e^+ + \nu$, and the related electron-capture reaction, $p + e^- + p \rightarrow {}^2D + \nu$, are presented. Estimates of the likely errors are given. The rates of some other electron-capture reactions that are of interest in connection with solar-neutrino experiments are also calculated. (auth)

14476 SURVEY OF HIGH-FREQUENCY RADIO RADIATION FROM PLANETARY NEBULAE. Kaftan-Kassim, May A. (State Univ. of New York, Albany). Astrophys. J., 155: 469-73(Feb. 1969).

Observations of 84 planetary nebulae at a frequency of 5000 MHz are reported. The data are presented in two tables. Table 1 contains objects whose flux densities are equal to or greater than three times the standard error, considered of greater reliability. Table 2 contains all planetary nebulae whose flux densities are equal to or greater than two times but less than three times the standard error, whose values are therefore significant only in statistical studies. The undetected objects are listed separately. Comparison is made with other surveys at the same frequency. (auth)

14477 REDDENING CURVES FOR PLANETARY NEBULAE. Pipher, Judith L.; Terzian, Yervant (Cornell Univ., Ithaca, N. Y.). Astrophys. J., 155: 475-83(Feb. 1969).

Absolute reddening curves are derived for selected planetary nebulae from a comparison of radio-continuum observations with observations of hydrogen recombination lines. The curves are compared with a suitably scaled mean extinction curve. The scaling factor is in agreement with the factor derived by the method of Aller and Minkowski. Significant deviations of Hα and other lines from the reddening curves are discussed. (auth)

14478 PASCHEN-LINE OBSERVATIONS OF THE ORION NEBULA. Werner, Michael W.; Pipher, Judith L.; Terzian, Yervant; Houck, J. R. (Cornell Univ., Ithaca, N. Y. Kitt Peak National Observatory, Tucson, Ariz.). Astrophys. J., 155: 485-9(Feb. 1969).

Measurements have been made of the absolute intensity of the (n = 12 → n = 3) Paschen line (P_{12},λ_0 = 8750.36Å) as a function of position across the Orion Nebula. The absolute extinction across the nebula is found by comparing these measurements with the radio measurements of Terzian, Mezger, and Schraml. A reddening curve has been derived for one location in the nebula from the hydrogen line intensities measured by Méndez. The results indicate that the Hα flux deviates in the direction of greater reddening, and that P_{12} deviates in the direction of lesser reddening, from a reddening curve defined by the other Balmer and Paschen lines. This is in agreement with the results of a similar investigation of planetary nebulae (Pipher and Terzian) and with an analysis of the hydrogen line intensities by Kaler. (auth)

14479 NEUTRINO EMISSION AND THE ONSET OF CARBON BURNING. Rose, William K. (Massachusetts Inst. of Tech., Cambridge). Astrophys. J., 155: 491-9(Feb. 1969).

Models for a $1.45M_{\odot}$ star were computed up to the onset of carbon burning. The models studied consist of a pure-helium envelope, a helium-burning shell, and a degenerate carbon–oxygen core. Although the envelopes of the computed models are deficient in hydrogen, the star becomes a red giant before the ignition of carbon. The time scale for the evolution of the star prior to carbon burning is sufficiently long for neutrino emission strongly to invert the temperature distribution of the degenerate core. The computed models reach very high values of L/M prior to carbon burning. As the star evolves, the neutrino-emission rates that arise in the core are eventually quenched by very high degeneracy, and consequently the temperature at the center of the star increases. Carbon burning begins when $\rho_{center} \approx 2 \times 10^9$ g cm^{-3}. The possible connection between the computed models and the occurrence of mass loss and supernova explosions is briefly discussed. The present calculations assume the existence of neutrino-emission processes that are predicted if the assumption of a universal Fermi interaction is correct. (auth)

Quasi-Stellar, Radio, and X-Ray Sources

Refer also to abstracts 14448 and 14556.

14480 LOW-ENERGY X-RAY SPECTRA OF SCO X-1 AND FOUR SAGITTARIUS SOURCES. Rappaport, S.; Bradt, H. V.; Naranan, S.; Spada, G. (Massachusetts Inst. of Tech., Cambridge). Nature (London), 221: 428-32(Feb. 1, 1969).

Studies of long-wavelength spectra of x-ray sources are described providing information about their distances and about the interstellar medium. (auth)(UK)

14481 CRAB NEBULA PULSAR NP 0532. Comella, J. M. (Arecibo Ionospheric Observatory, Puerto Rico); Craft, H. D.; Lovelace, R. V. E.; Sutton, J. M.; Tyler, G. L. Nature (London), 221: 453-4(Feb. 1, 1969).

The discovery of two pulsed radio sources near the Crab nebula has been reported. Pulses from both sources were described as very sporadic, with no periodic phenomena. Observations with the 1,000-ft antenna at the Arecibo Observatory, however, have revealed a periodicity associated with one of these sources (NP 0532). Some properties of this pulsar are described, including average pulse shape, dispersion, and features of the emitted strong pulses. The weaker source (NP 0527) was not detected. The periodicity of NP 0532 was found through spectral analysis, recorded digitally at 100 and 1,000 samples per sec. Analysis of the data gave strong responses at 30.22 Hz, corresponding to a period of 33.09 ms. Part of a record of the power spectrum obtained with the antenna pointing at the nebula is shown, and average pulse shapes are also reproduced. The average pulse shape resembles that of CP 0950, both showing a sub-pulse situated nearly, but not exactly, midway between the stronger pulses. The ratio of the energies in the sub-pulses was variable. The ratio of the pulse width to the pulse period was also of the same order for NP 0532 and CP 0950. No time variation in integrated electron content was detected. Results were also consistent with the dispersion relationship appropriate for a tenuous medium of free electrons. The strong pulses appear to occur at random times with an average separation much larger than the pulse period. The periods may be explained by neutron star rotation, but explanation in terms of the vibrations of white dwarfs is awkward since the excitation of very high-order modes would be required. (UK)

14482 EVIDENCE IN SUPPORT OF A ROTATIONAL MODEL FOR THE PULSAR PSR 0833-45. Radhakrishnan, V.; Cooke, D. J.; Komesaroff, M. M.; Morris, D. (Commonwealth Scientific and Industrial Research Organization, Sydney). Nature (London), 221: 443-6(Feb. 1, 1969).

Measurements of the pulsar tentatively identified with the supernova remnant Vela X support the rotational model. This pulsar is remarkable for the very high degree of linear polarization in its signals. (auth) (UK)

14483 MAGNETIC DIPOLE RADIATION FROM PULSARS. Gunn, J. E.; Ostriker, J. P. (Princeton Univ., N. J.). Nature (London), 221: 454-6(Feb. 1, 1969).

Pulsars have been discovered in Vela and near the Crab nebula which seem to be associated with supernova remnants and which have repetition periods considerably shorter than those previously found. The very wide range of periods observed for pulsars is difficult to understand if pulsars are pulsating objects of a single class, since an extremely wide density range would be required. Rotation seems to be the mechanism most consistent with the observations, and the extremely short periods make the suggestion of neutron stars more likely. The consequences of applying the rotation model are discussed, including magnetic dipole rotational effects, and the concepts are applied to the Crab pulsar, with extensions to other pulsars, including PSR 0833, which is associated with the supernova remnant Vela X. Dating considerations are also discussed. The findings appear consistent with a slow decay of the varying part of the magnetic moment, either by decay of the field or slow alignment with the rotation axis. It is seen that very large luminosities in very low frequency electromagnetic radiation, probably converted entirely to kinetic energy in relativistic particles near the source, are a necessary consequence of rotating magnetic neutron star models for pulsars. It is noted that the same mechanism of magnetic dipole radiation accelerating low density plasma to relativistic energies should work, on a more modest scale, in white dwarfs, and preliminary estimates indicate that, by this means, white dwarfs are energetically capable of contributing significantly to the cosmic ray background. (UK)

14484 OBSERVATION OF THE FIRST NEUTRON STAR. Atomes (Paris), 23: 319(May 1968). (In French).

Observations at 80 MHz at Cambridge since last July pointed to a signal of duration 0.35 sec, emitted at a rapidly changing frequency (retardation from interstellar plasma), with repetition at 1.337 sec constant to better than 1 part per 10^7, so that the signal must originate at a great distance. Absence of fixed parallax, and the frequency variation, fix it between 10^3 astronomical units and 65 parsecs; the dia of the source is less than 4800 Km. The spectrum indicates that the emission is not due to a synchrotron effect. The energy emitted is 10^{17} erg/impulse, with radiative power less than 10^5 MW. White dwarfs of density 10^7 g/cm^3 can oscillate with a period of several seconds; theoretical considerations suggests that neutron stars could oscillate with a period from 1 msec to 1 sec. In the vicinity of the radiosource there is a small weak star of the 18th magnitude, but identification is incomplete. Understanding of such phenomena will contribute to knowledge of stellar evolution and of very condensed states of matter. (BBB)

14485 DISCOVERY OF OPTICAL SIGNALS FROM PULSAR NP 0532. Cocke, W. J.; Disney, M. J.; Taylor, D. J. (Univ. of Arizona, Tucson). Nature (London), 221: 525-7(Feb. 8, 1969).

Strong light flashes have been detected from the fast pulsar in the Crab Nebula, using a 36-inch f/5 reflecting telescope. The optical pulses were observed to have a geocentric period of 0.033095 s, which agrees well with the projected heliocentric radio period. (auth)

14486 OPTICAL PULSATIONS IN THE CRAB NEBULA PULSAR. Nather, R. E.; Warner, B.; MacFarlane, M. (Univ. of Texas, Austin). Nature (London), 221: 527-9(Feb. 8, 1969).

The discovery of strong light flashes from pulsar NP 0532 was confirmed at the McDonald Observatory, using an 82-inch Struve telescope. (auth) (UK)

14487 NATURE OF RADIO AND OPTICAL EMISSIONS FROM PULSARS. Chiu, Hong-yee (Inst. of Space Studies, New York); Canuto, Vittorio; Fassio-Canuto, Laura. Nature (London), 221: 529-31(Feb. 8, 1969).

A report is given of how rotating and oscillating magnetic neutron stars can account for the radio and optical signals from pulsars. Several predictions of the nature of the signals are put forward. (auth) (UK)

14488 IMPLICATIONS OF OBSERVATIONS OF VERY-HIGH-ENERGY GAMMA RAYS FROM PULSARS. Apparao, M. V. K. (Smithsonian Astrophysical Observatory, Cambridge, Mass.). Nature (London), 221: 645(Feb. 15, 1969).

Gamma rays of energy above 7×10^{12} eV from CP 1133 have been reported. The ways in which these high-energy photons can be produced are examined, and implications are derived from the observations. High-energy gamma rays can be produced by the following processes: (1) decay of π^0 mesons produced by proton–proton reaction; (2) Compton scattering of universal microwave photons or other photons near the pulsar from ambient high-energy electrons; (3) bremsstrahlung of high energy electrons. In process (1) the production of high-energy electrons is implied, and these electrons can either escape from the pulsar region or be trapped and lose their energy by the synchrotron process near the pulsar. The case is considered in which no trapping occurs. In process (2) a magnetic field of $<10^{-7}$ gauss is implied, suggesting that this process as the origin of high-energy gamma rays is unlikely. In process (3) the number of electrons needed to produce the observed high-energy gamma rays depends on the

density of H atoms near the pulsar, and a magnetic field of $<10^{-5}$ gauss near the pulsar is implied. Whatever known process is assumed, the observed high-energy gamma radiation, together with the null optical observations, implies a magnetic field $<10^{-2}$ gauss near the gamma-ray emitting region of the pulsar. Theoretical suggestions of the magnetic field near the pulsars, if neutron stars, are as high as 10^{14} gauss. Considering the limits on the magnetic field set by each of the processes discussed, the most likely process is (1). It is also stated to be possible that pulsars can contribute significantly to cosmic rays. (UK)

14489 A STUDY OF VISUAL AND INFRARED OBSERVATIONS OF SCO XR-1. Neugebauer, G. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena); Oke, J. G.; Becklin, E.; Garmire, G. Astrophys. J., 155: 1-9 (Jan. 1969).

Photoelectric spectrum scans from 3300 to 10830 Å and infrared photometric observations at 1.65 and 2.2 μ of Sco XR-1 were obtained on many nights. The observed spectral energy distribution f_ν is nearly flat from 0.33 to 1.0 μ and then approaches a ν^2 law farther in the infrared. Synchrotron and free–free radiation can be ruled out unless a self-absorption mechanism operates in the visible spectral region. It is shown that the same mass of gas with $T = 5 \times 10^7$°K, which has been postulated to account for the x-ray data by free–free radiation can also account for the observed flux in the visible and infrared since it is shown that the optical depth in the visual and infrared is quite large. Very stringent conditions are imposed on such a model by the observations presented, and the parameters characterizing the hot plasma are listed. (auth)

14490 GAMMA-RAY LINES FROM YOUNG SUPERNOVA REMNANTS. Clayton, Donald D. (Rice Univ., Houston, Tex.); Colgate, Stirling A.; Fishman, Gerald J. Astrophys. J., 155: 75-82 (Jan. 1969).

The gamma-ray luminosity of a typical type-I supernova remnant was calculated by assuming that the origin of the optical luminosity is due to the energy of the radioactive decay of ^{56}Ni. It is expected that ^{56}Ni is the most abundant nucleus resulting from silicon burning in the supernova shock conditions. The requisite mass of ^{56}Ni ($0.14\ M_\odot$) gives rise to gamma-ray lines with energies near 1 MeV that should be detectable in young supernova remnants at distances up to a few Mpc. Future detectors aboard satellites should be able to detect events at the rate of about two observable events per year. A few supernova remnants in the Galaxy should be observable at all times in lines following the decay of ^{44}Ti. (auth)

14491 A NEW WAY OF DETERMINING THE OPTICAL DEPTH OF INTERSTELLAR NEUTRAL HYDROGEN CLOUDS. Heiles, C. (Univ. of California, Berkeley); Verschuur, G. L. Astrophys. Lett., 3: 21-2 (Jan. 1969).

Absorption spectra observations of radio sources whose intensity varies allow unambiguous determination of the optical depth of the absorbing clouds. (auth)

14492 A NEW TYPE OF WIDEBAND 1665 MHz OH EMISSION. Manchester, R. N.; Goss, W. M.; Robinson, B. J. (CSIRO, Sydney). Astrophys. Lett., 3: 11-14 (Jan. 1969).

A strong source of 1665-MHz OH emission has been discovered in the Carina region of the Galaxy. The emission covers a range of 50 km/sec in radial velocity and has a low degree of polarization. The source is in a region of weak continuum radiation between two H(II) regions. (auth)

14493 DETECTION OF THE GALACTIC RADIO LINE H56α: THE FIRST RADIO LINE OBSERVED IN THE MILLIMETER BAND. Sorochenko, R. L.; Puzanov, V. A.; Salomonovich, A. E.; Shteinshleger, V. B. (Lebedev Physical Inst., Moscow). Astrophys. Lett., 3: 7-10 (Jan. 1969).

The H56α recombination radio line ($\nu_0 = 36466.32$ MHz) was observed in the Omega Nebula. The observations were carries out using the Lebedev RT-22 radio telescope with an antenna beam width close to 2 arc min. An electron temperature of 7500 ± 1000°K was obtained for the part of the nebula with the brightest continuum radio emission. (auth)

14494 RADIO SIGNALS FROM HYDROXYL RADICALS. Barrett, Alan H. Sci. Amer., 219: No. 6, 37-44 (Dec. 1968).

The search for radio signals from interstellar hydroxyl radicals is reviewed and the properties of the intense sources in W3 are described in some detail. Results from the very-long-baseline interferometry program are given. OH emission from H(II) regions and infrared stars is discussed. (W.D.M.)

14495 DIFFUSE X-RAY BACKGROUND OF COSMIC SPACE. II. Vainshtein, L. A.; Syunyaev, R. A. Kosm. Issled., 6: 635-7 (July-Aug. 1968). (In Russian).

New measurements of x radiation in the soft energy region E = 0.28 keV ($\lambda = 44$ Å) and in the region 4 to 40 keV were recently reported by C. Bowyer et al. (Nature, 217, 32, 1968) and F. Seward et al. (Astrophys. J. 150, 845, 1967). The measured flux at E = 0.28 keV was equal to 270 quanta/cm^2 sec. ster. keV. The reported measurements also revealed unexpected small absorption of soft x radiation in the Galaxy in comparison with that anticipated according to the appraised quantity $n_H l$ observed during radio observations at $\lambda = 21$ cm. Newly reported data are used in a re-evaluation of the data obtained previously by the authors. Spectral distribution of the number of photons in the radiation of the diffuse background of cosmic space was constructed, considering the new and old data. Comparative studies indicate that the data on absorption of the L_α line in the interstellar media also produced the $n_H l$ smaller than observed at $\lambda = 21$ cm. The spectra for the region 1 to 30 keV are described by the formula: $I = 10E^{-1.65}$ quanta/cm^2 sec. ster. keV. The results of numerical data are tabulated. The data obtained take into consideration only homogeneous gases. (R.V.J.)

14496 PHOTOMETRIC SELECTION OF QUASI-STELLAR OBJECTS. Janes, K. (Naval Observatory, Flagstaff, Ariz.); Lynds, R. Astrophys. J., 155: L47-9 (Jan. 1969).

Five QSO candidates were selected from fifty-seven Tonantzintla blue stars by a red-excess criterion. A spectroscopic investigation of the candidates showed that one is a white dwarf and the remaining four are QSO's. (auth)

14497 ABSORPTION REDSHIFTS IN THE QUASI-STELLAR OBJECTS PHL 5200 AND B 194. Burbidge, E. Margaret (Univ. of California, San Diego). Astrophys. J., 155: L43-5 (Jan. 1969).

In a continuing study of QSO's with absorption lines in their spectra, further spectroscopic observations of PHL 5200 (4C – 5.93) and B194 were made. The absorption maxima of Si IV at $z = 1.950$ are still present in PHL 5200, and new absorption maxima were measured at $z = 1.891$. Two distinct red shifts, $z = 1.895$ and $z = 1.837$, were measured in B194. (auth)

14498 SEARCH FOR GAMMA RADIATION FROM CENTAURUS A. Haymes, R. C.; Ellis, D. V.; Fishman, G. J.; Glenn, S. W.; Kurfess, J. D. (Rice Univ., Houston, Tex.). Astrophys. J., 155: L31-4 (Jan. 1969).

A search is reported for radiation between 34 and 567 keV from a region in Centaurus that includes the radio galaxy Centaurus A. No radiation from Cen A at energy within this interval was detected, and upper limits to the flux were established. (W.D.M.)

14499 POSSIBLE TIME VARIATION OF THE RADIO EMISSION FROM SCO X-1. Ables, J. G. (Univ. of Adelaide). Astrophys. J., 155: L27-30 (Jan. 1969).

The radio object associated with Sco X-1 was observed at a wavelength of 6 cm with the 210-foot radio telescope at Parkes. The large antenna aperture and low noise temperature allowed measurements statistically superior to all previous ones to be made with an integration time short enough to test for the possibility of intensity time variations similar to some of those observed in photometric measurements of the optical counterpart of Sco X-1 and having characteristic time scales of tens of minutes to several hours. (W.D.M.)

14500 OBSERVATION OF CELESTIAL X-RAY SOURCES. Rocchia, R.; Boclet, D.; Durouchoux, Ph.; Rothenflug, R. (CEN, Saclay, France). Bull. Inform. Sci. Tech. (Paris), No. 131, 71-9 (Nov. 1968). (In French).

Current knowledge relative to cosmic x-ray astronomy in the 2- to 100-keV energy range is discussed, setting forth the main experimental data and hypotheses regarding the emission mechanism. Results gathered by the Saclay group in the 20- to 150-keV energy range, by the means of an experiment set up in a gondola are given. During two balloon-borne flights up to a 4 g.cm^{-2} residual pressure, the sources in the Cygnus region, especially Cygnus XI, and later the supernova remnant Taurus XI were observed. (auth)

14501 X-RAY BACKGROUND: OBSERVATION AND ORIGIN. Rothenflug, R.; Boclet, D.; Durouchoux, P.; Rocchia, R. (CEN, Saclay, France). Bull. Inform. Sci. Tech. (Paris), No. 131, 61-70 (Nov. 1968). (In French).

Results are presented relative to the diffuse cosmic x rays in the 10 to 100 keV energy range. Three flights of a balloon-borne experiment have shown that the observed flux is isotropic and that the intensity law per unit of energy has the form $NE = KE^{-\gamma}$, with $\gamma \simeq 2.4$. The phenomena which can induce such a flux of x rays are investigated: the main one appears to be the inverse Compton effect of electrons equally filling the intergalactic space and the

3°K black-body radiation, though the contribution of lots of sources can not be neglected. (auth)

14502 X-RAY ASTRONOMY. Ryter, Charles (CEN, Saclay, France). Bull. Inform. Sci. Tech. (Paris), No. 131, 51-9(Nov. 1968). (In French).

X-ray astronomy is briefly reviewed. The some 30 known sources are shown to belong mostly to the Milky Way. Their spectra, following either an exponential or a power law can be simply related to bremsstrahlung or synchrotron radiation, respectively. Orders of magnitude and formulae are given without proof for this mechanism. Typical astrophysical models are roughly recalled. The isotropic diffuse x-ray background is tentatively attributed to inverse Compton effect between relativistic electrons and the black-body radiation in the early evolving Universe. (auth)

14503 SPECTRA OF OPAQUE RADIO SOURCES. Kellermann, K. I.; Pauliny-Toth, I. I. K. (National Radio Astronomy Observatory, Green Bank, W. Va.). Astrophys. J., 155: L71-8 (Feb. 1969).

Radio spectra are shown for thirty radio sources that show evidence of synchrotron self-absorption. As a result of inverse Compton cooling and adiabatic expansion, all opaque components have a maximum brightness temperature in the range 10^{11} to 10^{12}°K. The magnetic field deduced from the surface brightness and cutoff frequency in these sources is generally about $10^{-4\pm1}$ gauss. The variable components appear to have somewhat stronger magnetic fields. (auth)

14504 DISCOVERY OF AN INTENSE OH EMISSION SOURCE. Eliasson, B.; Bartlett, J. F. (California Inst. of Tech., Pasadena). Astrophys. J., 155: L79-81(Feb. 1969).

This letter reports the discovery of a bright OH emission source at 1612.231 MHz in Canis Major. The source was discovered with the Owens Valley interferometer in Oct. 1968. The velocity profile of the Stokes parameters as measured with a 1600-foot spacing along a north–south base line are given. The source position was measured by analyzing the fringe phase at various hour angles. (W.D.M.)

14505 THE OCCULTATION POSITION OF AN OH EMISSION SOURCE IN W24. Cudaback, David D.; Welch, William J. (Univ. of California, Berkeley). Astrophys. J., 155: L83-5(Feb. 1969).

A lunar occultation of the 67.5 km sec^{-1} OH emission feature in W24 gives $\alpha(1950.0) = 17^h44^m10^s.78 \pm 0^s.15$ and $\delta(1950.0) = -28°22'53'' \pm 9''$. (auth)

14506 THE FLUX DENSITY OF TAURUS A AT 4.3-MM WAVELENGTH. Hobbs, R. W.; Corbett, H. H.; Santini, N. J. (Naval Research Lab., Washington, D. C.). Astrophys. J., 155: L87-9(Feb. 1969).

Previous measurements of Taurus A at wavelengths shorter than 8 mm have not been sufficient to determine its spectrum unambiguously; for this reason a measurement at 4.3 mm was undertaken. The present measurements were made with the 36-foot antenna at Kitt Peak. The total flux density was determined to be 281 ± 73 $W/m^2(c/s)^{-1}$. (W.D.M.)

14507 POSSIBLE CONVERSION OF ROTATIONAL ENERGY OF THE NEUTRON STAR IN THE CRAB NEBULA INTO ENERGY OF RELATIVISTIC ELECTRONS. Finzi, A. (Goddard Space Flight Center, New York); Wolf, R. A. Astrophys. J., 155: L107-8(Feb. 1969).

The observation that the period of the pulsating radio source in the Crab Nebula is increasing at a rate of 1 part in 2×10^3 per year suggests that a neutron star is releasing rotational energy at a rate of about 10^{39} ergs sec^{-1}, which is approximately the rate of energy release needed to account for the observed production of relativistic electrons at the center of the nebula. (auth)

14508 ON THE NATURE OF RYLE AND BAILEY'S CANDIDATE STAR FOR THE PULSATING RADIO SOURCE CP 1919. Westphal, J. A.; Kristian, Jerome; Snellen, Grant; Sandage, Allan; Schmidt, Maarten; Oke, J. B.; Neugebauer, Gerry; Becklin, E. E. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J., 155: L109-14(Feb. 1969).

The energy distribution and spectrum of the "blue" star near CP 1919 indicate that it is a normal early F, main-sequence star and therefore is not likely to be related to the radio source. No regular variations were found in the light from the star, to within an accuracy of a few tenths of 1%. (auth)

14509 OPTICAL IDENTIFICATION AND OBSERVATIONS OF THE PULSAR NP 0532. Lynds, R.; Maran, S. P.; Trumbo, D. E. (Kitt Peak National Observatory, Tucson, Ariz.). Astrophys. J., 155: L121-5(Feb. 1969).

Photoelectric observations with a 2''-diameter aperture clearly show that the source of the optical pulses discovered by Cocke, Disney, and Taylor for NP 0532 in the center of the Crab Nebula is Baade's "south preceding" star and that all, or nearly all, of the optical radiation appears in the form of pulses. Details of the light variation and preliminary UBV photometry are presented. New spectrograms of both components of the central double star confirm the earlier results of Minkowski. (auth)

14510 SEARCH FOR COSMIC GAMMA RADIATION IN THE SOUTHERN SKY. Duthie, J. G.; Osborn, R. W. (Univ. of Rochester, N. Y.). Phys. Rev., 176: 1505-6(Dec. 25, 1968).

A balloon-borne spark chamber was flown over western Queensland on November 26, 1966 in an attempt to detect cosmic photons of energy greater than 100 MeV emanating from several celestial objects of interest. No sources were found, and upper limits in agreement with those set by other observers were obtained. (auth)

14511 CRAB NEBULA PULSAR NP0527. Reifenstein III, Edward C.; Brundage, William D.; Staelin, David H. (National Radio Astronomy Observatory, Green Bank, W. Va.). Phys. Rev. Lett., 22: 311(Feb. 17, 1969).

Position measurements of the Crab nebula pulsar NP 0527 made with a split-beam antenna yield the position (1950) $\alpha = 05^h26^m10^s \pm 40^s$, $\delta = 22°0' \pm 30'$. Thus NP 0527 lies 1.2° from the pulsar NP 0532, which is located at the nebula. The proximity and similar dispersion of these two pulsars suggest that they have had a common origin in the supernova explosion of A.D. 1054 and hence that NP 0527 is moving with a velocity of ~0.15c, a hypothesis which could be tested directly by proper motion measurements. (auth)

14512 ROTATING NEUTRON STARS AND PULSAR EMISSION. Bertoti, B. (European Space Research Inst., Rome); Cavaliere, A.; Pacini, F. Nature (London), 221: 624-6(Feb. 15, 1969).

The oblique rotator model of a neutron star can provide a mechanism to transfer rotational energy into the circumstellar plasma, producing periodic shock waves. This mechanism is also relevant to the activity sometimes observed in supernovae remnants. (auth) (UK)

14513 DETECTION OF WATER IN INTERSTELLAR REGIONS BY ITS MICROWAVE RADIATION. Cheung, A. C.; Rank, D. M.; Townes, C. H.; Thornton, D. D.; Welch, W. J. (Univ. of California, Berkeley). Nature (London), 221: 626-8(Feb. 15, 1969).

Microwave emission from the $6_{16} \rightarrow 5_{23}$ rotational transition of H_2O has been observed from the directions of Sgr B2, the Orion Nebula, and the W49 source. This radiation, at 1.35-cm wavelength, was detected with the 20-ft radio telescope at the Hat Creek Observatory, using techniques described earlier for the detection of the NH_3 spectrum. In the case of Sgr B2, the H_2O emission is from the same direction in which considerable NH_3 is observed (unpublished work), although there is reason to believe the two molecular species may not be closely associated. Strong H_2O radiation producing an antenna temperature of 14°K is observed from the Orion Nebula (where no HN_3 was detected), and an antenna temperature at least as high as 55° was found for H_2O radiation from W49. (TSS) (UK)

14514 AN ABSOLUTE FLUX DENSITY SCALE AT 408 MHz. Wyllie, D. V. (Univ. of Sydney). Mon. Notic. Roy. Astron. Soc., 142: 229-40(1969).

Measurement of the absolute flux density at 408 MHz of five moderately strong radio sources by a method which has good sensitivity and negligible confusion problems is described. The flux densities of a further 37 sources are determined by relative measurement. The 42 sources are used to define an absolute flux density scale for the southern hemisphere. Comparison with absolute scales established in the north, using common sources, reveals a difference of approximately 10%, flux densities given by the present scale being the higher. (auth) (UK)

14515 DYNAMICS OF THE ORION NEBULA. II. SHOCK WAVES IN AN H II REGION. Dyson, J. E. (Univ. of Manchester, Eng.). Astrophys. Space Sci., 2: 461-73(Dec. 1968).

The collision of supersonic gas streams within an H II region is studied. A system of stationary shock waves is set up. Theoretical line profiles through these shocked regions are compared with those obtained in the bright central regions of the Orion Nebula. There is good agreement between the predicted and observed magnitude of line splitting in the forbidden lines of O^+ and O^{++}. (auth)

14516 DUST AND ATOMIC HYDROGEN NEAR ρ OPHIUCHI. Meszaros, P. (Instituto Argentino de Radioastronomia, Buenos Aires). Astrophys. Space Sci., 2: 510-19(Dec. 1968).

The distribution of dust and atomic hydrogen in and around a small dark cloud near ρ Ophiuchi is discussed. Although the obscuration reaches values as high as 8 magnitudes, the values of N_H derived inside the cloud do not differ markedly from those found at nearby, less obscured points. At low values of the obscuration, dust and hydrogen isophotes show satisfactory agreement, i.e., N_H increases with N_C. However, it is found that N_H starts decreasing for sufficiently large values of N_C. In the entire range of optical extinctions investigated, the observations are satisfied by an expression of the type $N_H = AN_C \exp(-BN_C)$. Interpretation of this relationship suggests that an appreciable part of the hydrogen has been converted to molecular form inside the cloud. A tentative method for calculating the time elapsed since the conversion process began is proposed. (auth)

14517 BALOON-BORNE OBSERVATORY FOR X-RAY ASTRONOMY. McCracken, K. G. (Univ. of Adelaide). Aust. Phys., 5: 171-6(Dec. 1968).

In 1966 it was decided to construct a balloon-borne x-ray observatory, capable of precise measurements of the x-ray energy spectra of weak x-ray objects. This article describes the observatory and the results obtained from its initial flight. During the initial flight, definitive spectra were obtained for three x-ray sources, the maximum exposure time for any given object being 10 minutes. (W.D.M.)

14518 INTERPLANETARY SCINTILLATIONS. IV. OBSERVATIONS NEAR THE SUN. Cohen, M. H. (Univ. of California, San Diego); Gundermann, E. J. Astrophys. J., 155: 645-63(Feb. 1969).

Interplanetary scintillations of 3C 279 are observed at wavelengths of 21 and 11 cm, at elongations from 4 to 35 $R_\odot$. The results are combined with observations of CTA 21 at 70 cm to derive a model of the fluctuations in the density of the solar wind. The random, thin-screen theory is used to describe the scintillations. It appears to give a correct description in all cases except for very narrow sources in strong scattering, where there is a conflict between the width and the integral of the frequency (wave number) spectrum of the observed fluctuations in intensity. This appears to be connected with the appearance of very short and intense "spikes" in the scintillation records, which produce a marked tail on the fluctuation spectra. A probable upper limit of 0".002 is set for the diameter of the scintillating component of 3C 279. (auth)

14519 MODELS OF PULSATING RADIO SOURCES. Warwick, James W. (Univ. of Colorado, Boulder). Science, 163: 959-61(Feb. 28, 1969).

Linear polarization of signals from CP 0950 on Apr. 3, 1968 indicates Faraday rotation of about 4 rad at 150 MHz (Smith 1968). This value is comparable with the total rotation expected from the ionosphere and sets an extremely sensitive upper limit on the weighted magnetic field through interstellar space. Smith comments "that there can be an appreciable Faraday rotation within the source of radiation, even though there must exist there a magnetic field large enough to generate the impulsive radiation." The relation between this feature of pulsar radiation and similar polarization phenomena occurring in Jovian decametric radiation is considered. (W.D.M.)

14520 STIMULATED COMPTON EFFECT AND QUASI-STELLAR OBJECTS. Oster, Ludwig (Joint Inst. for Lab. Astrophysics, Boulder, Colo.). Astrophys. Space Sci., 2: 438-47(Dec. 1968).

A computation is presented that predicts with sufficient accuracy the energy transfer between relativistic electrons and radio photons by means of stimulated Compton events. It is known that the majority of currently assumed parameters for quasi-stellar objects result in situations where the relativistic electrons must be produced initially at rather high energies ($\gamma \gtrsim 10^2$ to 10^3) in order to survive for any appreciable length of time. (auth)

14521 TRANSFER OF POLARIZATION OF RADIATION IN A MAGNETOACTIVE COSMIC PLASMA. Zheleznyakov, V. V. (Radiophysical Research Inst., Gorky, USSR). Astrophys. Space Sci., 2: 417-30(Dec. 1968).

The variation in the polarization of radiation propagating in a magnetoactive plasma due to the Faraday effect and differential absorption of ordinary and extraordinary waves is considered. This problem is especially important for polarization studies of the distributed cosmic emission, the radiation of discrete sources, etc. An equation describing the variation of the polarization tensor along the direction of propagation is formulated. This equation correctly accounts for the effect of absorption in distinction to the corresponding equation of Kawabata (1964). The equation obtained for a homogeneous medium is also true for an inhomogeneous plasma when the geometrical optics approximation is valid for the radiation, the difference between the refractions of ordinary and extraordinary waves is negligible, and inequalities are satisfied. In this case, however, the tensors will depend on the coordinate. (auth)

Solar Phenomena

Refer also to abstracts 14518, 14658, and 15059.

14522 (CEA-CONF-1066) HEAT GENERATION IN METEORITES DURING THE EARLY STAGE OF THE SOLAR SYSTEM. Reeves, H.; Audouze, J. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires. Centre National de la Recherche Scientifique, Paris (France). Institut d'Astrophysique). [1968]. 17p. (CONF-680834-1). Dep.

From International Symposium on Meteorite Research, Vienna, Austria.

The most efficient isotopes for heating of meteorites will have been those with a lifetime comparable to the period from the end of irradiation (T. Tauri phase) until the beginning of the solidification (main-sequence phase) of the solar system. This period can be given limits of 10^5 to 10^7 years. In this respect it is seen that two important isotopes are ^{10}Be and ^{26}Al. In this communication, some information on this early irradiation is used to study the importance of these heaters compared with others such as ^{40}K, ^{129}I, ^{235}U, and ^{244}Pu. (W.D.M.)

14523 COLLISION CROSS SECTIONS FOR TRANSITIONS BETWEEN ^{3}P LEVELS IN THE ISOELECTRONIC SEQUENCES OF N II AND P II. Suda, J. (Czechoslovak Academy of Sciences, Ondrejov). Bull. Astron. Inst. Czech., 19: 193-6(1968).

The method of quantum defects was used to determine the collision strength Ω for transitions between ^{3}P levels for N II, O III, F IV, P II, S III, and Cl IV ions. The results are given. The coefficients necessary for calculating the collision strength Ω are presented. A comparison of Ω obtained by the method of quantum defects and by other methods for N II and O III ions is given. (auth)

14524 ON THE TWO-COMPONENT STRUCTURE OF THE SUNSPOT MAGNETIC FIELD. Obridko, V. N. (Czechoslovak Academy of Sciences, Ondrejov). Bull. Astron. Inst. Czech., 19: 183-5(1968).

The magnetic intensification of Ti I, Ti II, Fe I, and Fe II lines in sunspot umbra is discussed, the data of Fricke and Elsässer (1965) and Makita (1963) being used. It is shown that high and low excitation lines are formed in the regions with different magnetic fields, the strength in the Fe II region is about two times smaller than in the Ti I. Direct measurements of magnetic splitting in Ti I and Fe II lines are in a good accordance with this result. (auth)

14525 ON THE TWO-COMPONENT SUNSPOT MODEL. Obridko, V. N. (Czechoslovak Academy of Sciences, Ondrejov). Bull. Astron. Inst. Czech., 19: 186-9(1968).

It is shown that the taking into consideration of inhomogeneities involves great changes in sunspot models. Several dense inhomogeneities may cause an increase of the spot opacity up to values comparable with the opacity of the photosphere. Taking into account the inhomogeneities would allow a rarefied but optically thick model of the sunspot to be built. (auth)

14526 INVESTIGATION OF OPTICAL AND RADIO PHENOMENA OF ACTIVE REGIONS IN THE MINIMUM OF SOLAR ACTIVITY. Kleczek, J. (Czechoslovak Academy of Sciences, Ondrejov); Olmr, J.; Krueger, A. Bull. Astron. Inst. Czech., 19: 190-3(1968).

The contribution to the s-component and burst activity of Zurich types of spot groups was deduced from the observational material of the last solar minimum. (auth)

14527 DEVELOPMENT OF PROTON REGION WITH FLARES AND IONOSPHERIC EFFECTS (JULY 26–SEPTEMBER 5, 1966. Krivsky, L. (Czechoslovak Academy of Sciences, Ondrejov); Nestorov, G. Bull. Astron. Inst. Czech., 19: 197-209(1968).

By using the method of summation curves, some parameters of the development of the active region which produced the proton flares of 8/28 and 9/2/66 are derived. The method of summation curves demonstrates the main trends of the development of the active region, and with flares and SID effects gives a true picture of the dependence on time of the change of the "energy loss". The change of the ionospheric absorption in the D region during daytime is characterized by other summation curves. These are constructed from the field intensity recordings of the long-wave transmitters. This absorption can be considered as a criterion

for a slowly varying x emission of active regions on the Sun. It is shown that in the period between August 26–27, as a consequence of interaction between spot groups in the photosphere, that a new configuration of magnetic fields of great dimensions developed. This fact predetermined for several days new developments and trends, and also caused the proton flares of 8/28 and 9/2/66. Ionospheric effects of the solar proton flares have been recorded in a wide range of frequencies from short to very long waves at various observatories. Some of the results obtained can also have a prognostic significance for forecasting proton flares: if a typical configuration of sunspot groups in interaction is being formed and simultaneously a jump in the activity occurs in the sense of an increase (especially with parameters F-flare, SIDs, B-index of field intensity of long radio waves disturbances, and ionospheric absorption), a proton flare will develop in this region within 2 to 3 days. (auth)

14528 BRIGHTNESS DISTRIBUTION OF SOFT X-RAYS ON THE SUN, INFERRED FROM IONOSPHERIC E-LAYER VARIATIONS DURING AN ECLIPSE. Taubenheim, J.; Serafimov, K. (Heinrich-Hertz-Institut fuer Solar-Terrestrische Physik, Berlin). J. Atmos. Terrest. Phys., 31: 307-12(Feb. 1969).

Solar eclipse variations of the E-layer critical frequency at two stations near the central line of the eclipse of May 20, 1966, can be explained by quasi-equilibrium (constant effective recombination coefficient $\alpha_{eff} \geq 8 \times 10^{-8}$ cm^3 sec^{-1}) between the electron density and the ionizing soft x-ray radiation emitted nonuniformly from the Sun. The ionospheric data are fitted well by a brightness distribution model attributing 27% of the solar emission to the limb corona (including two localized bright parts of the limb), and 70% to a uniform disk radiation, in fair agreement with Elwert's (1958) theoretical estimations for soft x rays. A source of hard x-ray emission near the central meridian, as found in the SOLRAD-satellite measurements during the eclipse, had only a very small influence on the E-layer variation. This leads to the assumption that the soft x rays from local sources, in contrast to the hard x rays, exceed the realtively high uniform-disk background level only when the sources approach the solar limb. (auth) (UK)

14529 POSSIBLE RELATION OF A NULL SOLAR NEUTRINO FLUX TO THE 11-YEAR SOLAR CYCLE. Sheldon, W. R. (Univ. of Houston, Tex.). Nature (London), 221: 650-1(Feb. 15, 1969).

In some experimental measurements of the flux of neutrinos from the Sun the number of neutrinos detected did not exceed the measured background for the instrument, and hence served only to provide an upper limit for the flux of energetic solar neutrinos. The authors concerned concluded that <9% of the Sun's energy is produced by the C–N cycle. Interpretations of these findings by other authors are discussed. The present author suggests that no solar neutrinos were observed because the solar neutrino flux was zero at the time, and possible reasons for a zero flux are discussed. The flux at times could be much higher than predicted on the basis of a constant energy source, and at other times could be zero. A solar energy source which fluctuates in intensity seems reasonable, since laboratory attempts to reproduce the Sun's nuclear reactions on a steady state basis have revealed plasma instabilities which inhibit the reactions. The most likely cyclic period for such results to occur is examined. Should pulsation of the solar energy source prove to have a basis in fact, the possibility of probing the Sun's interior might arise. There is also the possibility that neutrino flux observations could serve as accurate long range predictors of solar cosmic-ray activity. Further experimental work, continuously over a complete 11 year solar cycle, is indicated. (UK)

14530 CALCULATIONS OF IONIZATION EQUILIBRIA FOR OXYGEN, NEON, SILICON, AND IRON. Allen, J. W.; Dupree, A. K. (Harvard Coll. Observatory, Cambridge, Mass.). Astrophys. J., 155: 27-36(Jan. 1969).

The ionization equilibrium in a low-density plasma was calculated for the elements oxygen, neon, silicon, and iron. The processes of dielectronic recombination and auto-ionization are included. (auth)

14531 THE EFFECT OF THE BRANS–DICKE COSMOLOGY ON SOLAR EVOLUTION AND NEUTRINO FLUXES. Shaviv, G. (Cornell Univ., Ithaca, N. Y.); Bahcall, J. N. Astrophys. J., 155: 135-43(Jan. 1969).

The effect of the Brans–Dicke theory of gravitation on the evolution of the Sun and the solar neutrino flux was investigated. The results, for fashionable values of the scalar field coupling constant, the Hubble constant, and the heavy-element abundance, are (1) the solar luminosity decreased by about 10 to 50% during the last 4.7 billion years; and (2) the solar neutrino flux for the Brans–Dicke theory is greater than the corresponding flux for constant-G theories by a factor of about 2. (auth)

14532 THE FOURTH POSITIVE SYSTEM OF CARBON MONOXIDE OBSERVED IN ABSORPTION AT HIGH RESOLUTION IN THE VACUUM ULTRAVIOLET REGION. Simmons, J. D. (National Bureau of Standards, Washington, D. C.); Bass, Arnold M.; Tilford, S. G. Astrophys. J., 155: 345-58(Jan. 1969).

The fourth positive system ($A^1\Pi - X^1\Sigma^+$) of carbon monoxide was observed in absorption at high resolution in the region 1550 to 1060 Å. The rotational and vibrational structure of twenty-three bands was analyzed, viz., the $v'' = 0$ progression for $v' = 0-18$, 20, 21, and 23 in addition to the (0,1)-band. A detailed assignment of the numerous perturbations in the $A^1\Pi$ state is given. Most of these perturbations can easily be attributed to the six known states in the region of the $A^1\Pi$ state. The observed $v' = 23$ level lies above the accepted dissociation limit of CO which indicates a maximum in the potential curve for the $A^1\Pi$ state. (auth)

14533 THE OCCULTING DISK OF THE SUN AT RADIO WAVELENGTHS. Bracewell, R. N.; Eshleman, V. R.; Hollweg, Joseph V. (Stanford Univ., Calif. Massachusetts Inst. of Tech., Cambridge). Astrophys. J., 155: 367-8(Jan. 1969).

The angular size of the occulting disk of the Sun at radio wavelengths, which depends on the deviation of slightly deviated rays traversing the outer solar corona, can be calculated simply without resorting to ray tracing. (auth)

14534 COLLISIONLESS HEATING OF THE SOLAR-WIND PLASMA. II. APPLICATION OF THE THEORY OF PLASMA HEATING BY HYDROMAGNETIC WAVES. Barnes, Aaron (Ames Research Center, Moffett Field, Calif.). Astrophys. J., 155: 311-21(Jan. 1969).

The theory of heating of collisionless plasma by damping hydromagnetic waves is applied in a qualitative model of solar-wind heating. It is proposed that an efflux of 5×10^{26} ergs sec^{-1}, in the form of fast-mode magnetoacoustic waves, propagates outward into the outer corona. Most of this wave energy is transformed into electron and ion thermal energy through damping, within a few solar radii, and is expected to enhance the velocity of the wind at the orbit of the Earth. A smaller amount of this wave energy will not be absorbed until it has propagated far from the Sun; the absorption of this part of the wave energy will enhance the temperature of the solar-wind ions, and because the ion–ion mean free path is long in this region, the ion temperature will remain high even at the orbit of Earth. The proposed heating model qualitatively accounts for the discrepancy between observed solar-wind velocities and ion temperatures, and those predicted by the Sturrock–Hartle two-fluid model of the solar wind. (auth)

14535 THE TOPOLOGY OF AN AXISYMMETRIC MAGNETIC FIELD OF A DIFFERENTIALLY ROTATING SUN. Nakagawa, Y.; Swarztrauber, P. (High Altitude Observatory, Boulder, Colo.). Astrophys. J., 155: 295-310(Jan. 1969).

Simultaneous numerical solutions of the hydromagnetic equations were obtained for a differentially rotating Sun within the context of axisymmetric incompressible hydromagnetics. It is assumed that the observed solar differential rotation is maintained at the surface and that a constant angular velocity of rotation is maintained at the bottom of the convection zone. The solutions thus obtained show several interesting topological features of the general solar magnetic field, such as the development of a strong toroidal (longitudinal) magnetic field in the middle latitude which gradually drifts by a meridional circulation either toward the equator or toward the pole, depending upon the formula used to describe the surface differential rotation. With the use of the formula derived from the observed movement of sunspots, the equatorial drift is obtained. In this case, if the region of strong toroidal magnetic field is identified with the zone of sunspot activity, it is shown that the zone of activity drifts toward the equator with the period which could be adjusted close to the 11-year cycle. With the formula derived from the movement of filaments, the polar drift is obtained, and in this case, if the region of strong toroidal magnetic field is identified with the zone of polar prominence activity, the development and the drift of polar prominences toward the pole are reproduced. The implications of these results are discussed together with their limitations. (auth)

14536 TIME DEPENDENCE OF RAZIN SPECTRA IN TYPE IV SOLAR RADIO BURSTS. Simon, M. (Carnegie Inst. of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. Lett., 3: 23-4(Jan. 1969).

It is shown that variations in the spectrum of a type-IV radio burst as the source rises through the solar corona may be used to test the hypothesis that the low-frequency cutoff is due to the Razin effect. The intensity variations in the burst described by Boischot and Clavelier (1968) fit the theory well and, in principle,

can be used to determine the electron density and magnetic field distributions in the corona. (auth)

14537 VARIATIONS OF ION FLUX OF SOLAR WIND ON INCREASE OF LEVEL OF SOLAR ACTIVITY ACCORDING TO THE MEASUREMENTS WITH INSTRUMENTS ON "VENERA-2" AND "VENERA-4". Gringauz, K. I.; Solomatina, E. K. Kosm. Issled., 6: 586-9(July–Aug. 1968). (In Russian).

Results are compared from observations of solar-wind flux near the Earth, obtained in 1965 "Venera-2" instruments and in 1967 with "Venera-4" instruments. Conclusions are given concerning the increase of solar-wind flux with the increase of solar activity. (tr-auth)

14538 SOLAR PROTON EVENTS. Axisa, F. (CEN, Saclay, France). Bull. Inform. Sci. Tech. (Paris), No. 131, 17-27(Nov. 1968). (In French).

A brief review of solar proton flares injecting bursts of cosmic rays into the solar system, is presented. Optical and radio-astronomy observations have given a coherent picture of the development of the flares; measurements of the solar cosmic rays near the Earth have already allowed a fairly good understanding of the main features of cosmic-ray propagation in the interplanetary medium. However the description one can give remains qualitative and the detailed mechanism of the flare itself remains unknown. The experiments now in preparation at the "Service d'Electronique Physique" are briefly described. Their purpose is to measure the energy distributions of protons aboard the European Satellites: ESRO II and HEOS. (auth)

14539 SIXTEEN-SECOND PERIODIC PULSATIONS OBSERVED IN THE CORRELATED MICROWAVE AND ENERGETIC X-RAY EMISSION FROM A SOLAR FLARE. Parks, G. K.; Winckler, J. R. (Univ. of Minnesota, Minneapolis). Astrophys. J., 155: L117-20(Feb. 1969).

The solar x-ray event of August 8, 1968, detected on a high-altitude balloon shows a 16-sec periodic modulation in the x-ray intensity–time profile. These periodic variations correlate well with the fine features in microwave radio-emission data. The x-ray energy spectrum as determined from a two-channel energy discriminator hardens during peaks of modulations. (auth)

14540 CENTRAL CONVECTION AND SOLAR NEUTRINOS. Iben, Icko Jr. (Massachusetts Inst. of Tech., Cambridge). Astrophys. J., 155: L101-5(Feb. 1969).

Mixing in a convective core on a time scale that is short compared to the lifetime of ^{7}Be against electron capture would reduce the flux of neutrinos resulting from ^{8}B decay near the solar center. (auth)

14541 SOLAR C II RESONANCE-LINE PROFILES. Berger, Richard A. (Univ. of Colorado, Boulder); Bruner, Elmo C. Jr. Astrophys. J., 155: L115-16(Feb. 1969).

A preliminary report is given on the results of the Nov. 21, 1968, Aerobee flight (NASA 4.240 US) at White Sands. A high-resolution ichelle spectrograph oriented in a biaxial pointing control, obtained stigmatic profiles of the solar C II doublet ($\lambda\lambda$ 1334, 1336). A microdensitometer trace of a portion of the λ1336 line is shown. (W.D.M.)

14542 A SUGGESTION FOR THE MEASUREMENT OF He II LINE INTENSITIES EMITTED BY THE SUN. Hearn, A. G. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Mon. Notic. Roy. Astron. Soc., 142: 259-63(1969).

Measurements of the intensities of the Lyman α, Lyman β, and Balmer α lines of He II emitted by the Sun would give the electron temperature and density and the optical thickness of the layer emitting these lines. The results of calculations which are sufficient to interpret the observations are included. Measurements without any spatial resolution would be well worth making. If the measurements could be made with spatial resolution they would provide the first really quantitative information on the differences between plage and quiet regions. A measurement of the geometrical thickness of the layer emitting the lines would give the first spectroscopic determination of the helium abundance of the chromosphere. (auth) (UK)

14543 INFLUENCE OF NEUTRAL INTERSTELLAR MATTER ON THE UPPER ATMOSPHERE. Fahr, H. J. (Univ., Bonn). Astrophys. Space Sci., 2: 474-95(Dec. 1968).

Neutral interstellar matter entering the solar system has been considered in respect to its influences on the upper atmosphere. Calculations show that in consequence of the focusing effect due to the Sun's gravitational field the incoming neutral hydrogen and helium under special, but possible, conditions will represent a semi-annually varying density along the Earth's orbit. The particle fluxes amounting at least to some 10^{7} cm^{-2} sec^{-1}, which are connected with these density profiles and reach the upper atmosphere, show annual periodicities and so will cause annual variations of the densities of the light, atmospheric gas constituents. Especially, it is to be expected that so-produced density variations of atmospheric hydrogen are important. Temperature increases caused by the energy flux of interstellar particles should in general only amount to a few thousandths of the CIRA temperatures. (auth)

14544 NEUTRAL CORPUSCULAR ENERGY FLUX BY CHARGE-TRANSFER COLLISIONS IN THE VICINITY OF THE SUN. Fahr, H. J. (Univ., Bonn). Astrophys. Space Sci., 2: 496-503(Dec. 1968).

Charge-transfer collisions between solar-wind protons and neutral interstellar hydrogen in the vicinity of the Sun were considered. Due to the focusing effect of the Sun's gravitational field interstellar particles entering the solar system in free flights produce a specific density distribution in the circumsolar space. On their way from the Sun to the orbit of the Earth solar protons will therefore generate fast neutrals by collisions with neutral hydrogen. Depending on the position at its orbit the Earth will be hit by these fast neutrals which will come down directly into the thermosphere and will produce temperature and density increases. It is shown that the corpuscular energy flux connected with these fast neutrals will have a semi-annually varying profile along the Earth's orbit. Interstellar particle densities of about 5 cm^{-3} at infinity would produce energy fluxes of the order of 0.1 erg/cm^{2} sec. Assuming a specific proper motion of interstellar matter surrounding the solar system we obtain a neutral corpuscular energy flux having nearly the same shape and phase as the well-known semi-annual effect in atmospheric temperatures and densities. Collision-generated, fast neutrals reaching the Earth could therefore possibly give an explanation of this effect. (auth)

14545 CENTRAL INTENSITIES OF FRAUNHOFER LINES NEAR SOLAR MINIMUM. Chamberlain, Joseph W. (Kitt Peak National Observatory, Tucson, Ariz.). Astrophys. J., 155: 709-14(Feb. 1969).

The central intensities of 310 lines relatively free from blends in the region 5880 to 4700 Å were measured in the double-pass atlases made at the Snow telescope in September 1962 and September 1966. These results have now been compared with the results of the Soviet astronomers (Derviz, Kuprevich, and Mitrofanova) with an eye to their possible variation in the solar cycle. There is agreement in sense with the Soviet results, but the variation with sunspot number is estimated to be only one-third as great. (auth)

14546 ON THE SOLUTION OF THE TRANSFER EQUATION FOR CONTINUUM RADIATION IN INHOMOGENEOUS ATMOSPHERES. Wilson, P. R. (Joint Inst. for Lab. Astrophysics, Boulder, Colo.). Astrophys. J., 155: 715-17(Feb. 1969).

A successful method of solving the equation of radiative transfer for a spectral line formed in a two-dimensionally varying atmosphere is adapted to continuum radiation. An important modification to the method, necessitated by the large horizontal intensity fluctuations found near the boundaries of large solar granules and sunspots, is described. (auth)

14547 HARTREE–FOCK CALCULATIONS OF CORONAL FORBIDDEN LINES IN THE ARGON I ISOELECTRONIC SEQUENCE. Wagner, William J. (Univ. of Colorado, Boulder); House, Lewis L. Astrophys. J., 155: 677-86(Feb. 1969).

In the Argon I isoelectronic sequence it is highly likely that coronal forbidden visible transitions will be discovered occurring between levels of the lowest excited configuration $3p^{5}3d$. Hartree–Fock calculations of wavelengths and magnetic dipole and electric quadrupole transition probabilities have been made in the ions Cr VII to Cu XII. In these stages thirty-four forbidden lines are predicted having transition probabilities greater than 1 sec^{-1}. Due to large uncertainties inherent in state-of-the-art self-consistent field calculations, the predicted wavelengths have insufficient accuracy at present to allow a unique identification with coronal lines observed at eclipses. (auth)

14548 ABSORPTION SPECTRA OF Zn I, Cd I, AND Hg I IN THE VACUUM ULTRAVIOLET. Garton, W. R. S.; Connerade, J. P. (Imperial Coll. of Science and Tech., London). Astrophys. J., 155: 667-75(Feb. 1969).

A new investigation of the absorption spectra of Zn, Cd, and Hg vapors in the region 600 to 950 Å has yielded considerable extension and some amendment of early results of Beutler. The spectra readily resolve into long series of types $d^{10}s^{2}\ {}^{1}S_{0}-d^{9}s^{2}$ np, nf which are tabulated in the (J_cK) coupling notation, and contain marked examples of auto-ionization "resonance profiles." In Hg I a new isolated "window resonance" has been found. (auth)

14549 MEASUREMENT OF CHROMOSPHERIC HEIGHTS. Mitchell, Walter E. Jr. (Ohio Wesleyan Univ., Delaware. Ohio State Univ., Columbus). Astrophys. J., 155: 665-6(Feb. 1969).

A method is proposed for the photoelectric measurement of chromospheric heights which requires neither high telescopic resolution nor the very best seeing. It employs slicing of the solar image, controlled oscillation of opposing solar limbs at the spectrograph slit, and feeding of the photoelectric output to a digital storage oscilloscope. Trials with the apparatus during September 1967 at the Snow telescope yielded estimates of limb heights in Hβ and in the H-line of Ca II. (auth)

Galaxies

Refer also to abstract 14652.

14550 NEUTRAL HYDROGEN ASYMMETRY IN THE GALAXY M101 AS EVIDENCE FOR TIDAL EFFECTS. Beale, J. S.; Davies, R. D. (Univ. of Manchester, Jodrell Bank, Eng.). Nature (London), 221: 531-3(Feb. 8, 1969).

Measurements of the distribution of neutral hydrogen in the galaxy M101 have revealed an asymmetry which raises interesting points about tidal effects in galaxies due to nearby companions. (auth) (UK)

14551 10-MHz ABSORPTION IN THE LOCAL SPIRAL ARM. Bridle, A. H. (Queen's Univ., Kingston, Can.). Nature (London), 221: 648-9(Feb. 15, 1969).

The finding of attenuation of the 10 MHz flux densities for radio sources near the galactic equator suggests that free–free absorption in the interstellar medium of the galaxy is significant at that frequency. The present author considers 10 MHz observations of galactic sources with known distances, and of sources identified with extragalactic objects at $|b^{II}| < 20°$. For these sources the length of the line of sight through the interstellar medium can be estimated, and the observed absorption provides data on physical conditions in that medium. It was found that the optical depth per parsec is greater for lines of sight lying parallel to the local spiral arm than for perpendicular lines by a factor of 2 to 3, depending on the assumed thickness of the galactic disk. This relation to the spiral structure of the Galaxy confirms that the 10 MHz data show the effect of interstellar absorption, and suggests that this absorption is dominated by the local spiral arm. Further analysis was therefore made using galactic models taking account of the orientation of the local arm, and results are tabulated. It was found that only 3C 10 and Cas A of the sources examined showed appreciable absorption beyond the local spiral arm. It is stated to be more satisfactory to suppose that the 10 MHz absorption occurs in "cool" electron gas (100°K) rather than in "hot" gas (6,000°K), and it is important to consider the effect of aggregation of the electrons into clouds. The relevance of Faraday rotation data is also considered. (UK)

14552 OVERSTABILITY OF THIN STELLAR SYSTEMS. Julian, William H. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J., 155: 117-22(Jan. 1969).

The stability of thin, rotating disks of stars with respect to small-scale, axisymmetric disturbances is reexamined, taking into account possible overstabilities. These overstabilities are shown to be absent whenever the density of stars in phase space is a decreasing function of epicyclic amplitude. There always exist, in such cases, both a maximum wavelength of disturbance and a maximum rms random speed (each dependent on the epicyclic frequency and the details of the velocity distribution function) beyond which all simple instabilities are likewise avoided. Overstabilities are shown to occur in the case of no rotation if the distribution of stellar velocities in any given direction has a sufficiently high relative maximum at a nonzero velocity. In the presence of rotation, they are shown explicitly to arise for that velocity distribution function in which the sizes of all epicycles are equal. These considerations suggest that the velocity distributions of the stars in disk galaxies must be similar in shape if not detail to the Schwarzschild distribution, if they are to avoid such more complicated gravitational instabilities. (auth)

14553 AGE OF THE GALAXY FROM THE DECAY OF URANIUM. Dicke, R. H. (Palmer Physical Lab., Princeton, N. J.). Astrophys. J., 155: 123-34(Jan. 1969).

The dating of the Galaxy by the decay of uranium is reexamined. From recently published data it is concluded that the Galaxy is approximately 7×10^9 years old, substantially the same as the "prompt synthesis" age derived eleven years ago by Burbidge, Burbidge, Fowler, and Hoyle. Contrary to current beliefs, the results obtained from the decay of ^{235}U relative to ^{238}U, assuming "prompt synthesis," are concordant with those based on the decay of ^{238}U relative to ^{232}Th. (auth)

14554 RADIO EMISSION OF NORMAL GALAXIES. Lang, K. R. (Stanford Univ., Calif.); Terzian, Y. Astrophys. Lett., 3: 29-31(Jan. 1969).

Observations of 39 normal galaxies at 430 and 611 MHz are reported. When they are combined with other observations at high frequencies, a transition in the spectrum is noticed, the spectrum becoming flatter at lower frequencies. (auth)

14555 LUMINOSITY–DIAMETER RELATIONS FOR GALAXIES. Heidmann, J. (Univ. of Texas, Austin). Astrophys. Lett., 3: 19-20(Jan. 1969).

Further evidence supports the observation that the linear diameter of a galaxy is a function of only two parameters: its absolute luminosity and its type. (auth)

14556 SEYFERT GALAXIES. Weymann, Ray J. Sci. Amer., 220: No. 1, 28-37(Jan. 1969).

The observed properties of the Seyfert galaxies are discussed and their points of similarity with some of the quasars are indicated. Various models for the galaxies are considered along with models for quasars. (W.D.M.)

14557 STATISTICAL STUDY OF VARIABLES IN THE MAGELLANIC CLOUDS. IV. POSITION AND COLOR OF 273 NEW VARIABLES IN THE "A" REGION OF THE LARGE CLOUDS. Dessy, Jorge Landi; Laborde, Jose R. (Univ. Nacional, Cordoba, Argentina). Bol. Inst. Mat. Astron. Fis., 2: No. 6, 3-12(Dec. 1965). (In Spanish).

A statistical discussion of these variables published in March 1963 in I.A.O. Symposium No. 20 in Sydney, Australia, contains no list of positions. This list is given now and also a new chart, as the original one is not sufficient for accurate location of the variables. The region is centered at the star HD 38215. Coordinates of Córdoba Variables are in millimetres from centre of plate, which was divided into four zones, to enable easy identification of variables. The + sign of the abscissa corresponds to E and of the ordinate to N. The Córdoba Variable number (C.V.) in x and y coordinates and color (b = white, a = yellow, r = red) are given. It is noticeable that no atlas up to now, including the Hodge–Wright atlas of the L.M.C. contains any Córdoba Variables, which makes their localization difficult. In the system of coordinates the star HD 38215 has the values x = +0.2 mm y = +4.0 mm. (auth)

14558 WATER-VAPOR CLOUDS IN THE INTERSTELLAR MEDIUM. Snyder, Lewis E.; Buhl, David (National Radio Astronomy Observatory, Green Bank, W. Va.). Astrophys. J., 155: L65-70(Feb. 1969).

A calculation of the number of molecules in the line of sight necessary for the detection of an interstellar water-vapor cloud was made for the 22.2- and 183.3-GHz rotational lines. Curves are presented for a minimum detectable line intensity of 1°K, assuming a transparent atmosphere and an ideal radio telescope. In the case of the 22.2-GHz line, the number of molecules per square centimeter in the beam is found to be between 10^{16} and 10^{17} for a state temperature of 100 to 200°K. The 183.3-GHz line requires 10^{15} cm^{-2} at a state temperature of 40°K; however, this line can be detected only above the Earth's atmosphere. Consideration is given to a search for emission and absorption in interstellar water clouds, using the National Radio Astronomy Observatory's 140-foot radio telescope. (auth)

14559 A SURVEY OF DUST CLOUDS FOR OH EMISSION. Cudaback, D. D.; Heiles, C. (Univ. of California, Berkeley). Astrophys. J., 155: L21-6(Jan. 1969).

OH was detected in twenty out of seventy-nine interstellar dust clouds. Radial velocity is close to that of nearby hydrogen. The clouds at very low galactic latitude show the OH in absorption. (auth)

14560 FAR-INFRARED OBSERVATION OF THE GALACTIC-CENTER REGION AT 100 MICRONS. Hoffmann, William F. (Goddard Inst. for Space Studies, Greenbelt, Md.); Frederick, Carl L. Astrophys. J., 155: L9-13(Jan. 1969).

An intense far-infrared source has been detected at 100 μ in the direction of the galactic center. The source has an extension along the galactic plane of at least 6°.5, a flux density of $1.8 \pm 0.8 \times 10^{-19}$ W m^{-2} Hz^{-1}, and a brightness temperature averaged over a 2°.3 beam width of 16°K. If the source is at the distance of the galactic center, its luminosity is 2.7×10^{42} ergs sec^{-1}. A possible mechanism is thermal emission of interstellar dust grains. The intensity is 30 times that anticipated for this process. (auth)

14561 EMISSION MECHANISM OF RADIOGALAXIES. Surdin, Maurice (Faculte des Sciences, Bordeaux). Compt. Rend., Ser. A and B, 267: 473-6(Aug. 19, 1968). (In French).

The component dependent on the frequency of the radio emission of Cygne A and of NGC 4486 is attributed to the fluctuations of the magnetic fields of the ionized clouds of these galaxies. (tr-auth)

14562 DISSOCIATION–IONIZATION FRONTS IN INTERSTELLAR GAS CLOUDS. III. STRUCTURE AND PROPAGATION OF D-TYPE FRONTS AND THEIR ASSOCIATED SHOCK FRONTS. Mendis, D. A. (Univ. of Manchester, Eng.). Mon. Notic. Roy. Astron. Soc., 142: 241-58(1969).

The later phase of the development of a Strömgren sphere in an interstellar cloud of molecular hydrogen is considered. The structures of D-type dissociation–ionization fronts and their associated shock fronts are computed using a quasi-steady flow approximation. The shock, which forms within the dissociation–ionization front towards the end of the preceding phase, emerges from it, thereby converting it into a weak D-type. Once the shock emerges, it heats the neutral gas to a temperature of the order of 10^4°K, but strong radiative cooling by the molecules brings the temperature down to its original value (~100°K) within a short time. The final compression of the gas in the shocked region is of the order of 10^3. Collisional dissociation of the molecules, and self absorption of the cooling line radiation within the shocked region, are shown to be unimportant. As the shock and the dissociation–ionization front slow down, they draw apart. The initial temperature and the final compression behind the shock decrease. Finally the shock degenerates into an ordinary sound wave. Although the "initial Strömgren sphere" in both the molecular and the atomic cases is of the same size, the final "equilibrium Strömgren sphere" in the molecular case is about 1.6 times larger than that in the atomic case. (auth) (UK)

14563 OLD GALACTIC CLUSTER NGC 3680. Eggen, O. J. (Australian National Univ., Canberra). Astrophys. J., 155: 439-45(Feb. 1969).

Photoelectric (UBV) observations were obtained for 79 stars in and near the galactic cluster NGC 3680. The cluster (a) has, within the observational uncertainty, a modulus identical with that of M67 (9.5 mag), (b) is probably only slightly younger than M67, (c) has stars with the same (or possibly somewhat lower) metal abundance as the members of M67, and (d) shows a pronounced gap in the distribution of evolved stars near the main sequence at $M_V = +3.1$. Early-type stars near the cluster give $E(B-V) = +0.04$. Although several features of the color-luminosity array indicate that NGC 3680 is slightly younger than M67, the clump of red giants, characteristic of old clusters, is redder in NGC 3680. (auth)

14564 STUDIES OF EXTREMELY YOUNG CLUSTERS. V. STARS IN THE VICINITY OF THE ORION NEBULA. Walker, Merle F. (Univ. of California, Santa Cruz). Astrophys. J., 155: 447-68(Feb. 1969).

Three-color photoelectric observations of stars in the vicinity of the Orion Nebula are presented. Most of the stars observed are brighter than V = 14, but a few fainter stars have been included to V = 18. The color–magnitude diagram for the Orion Nebula stars is very similar to that of NGC 2264, except that the point at which the fainter, gravitationally contracting stars depart from the zero-age main sequence is at $(B-V)_0 = -0.09$, whereas in NGC 2264 it is at $(B-V)_0 = 0.00$. According to the most recent theoretical calculations, the gravitational contraction age corresponding to the observed turnoff point in Orion is 3×10^6 years and appears to be the same for stars in all parts of the Orion Nebula region. The present three-color photometric observations indicate that the ratio of total to selective absorption is normal in the vicinity of the Orion Nebula. (auth)

14565 PRODUCTION OF COSMIC GAMMA RAYS BY COMPTON SCATTERING IN DISCRETE SOURCES. Rieke, G. H. (Smithsonian Astrophysical Observatory, Tubac, Ariz. Harvard Univ., Cambridge, Mass.); Weekes, T. C. Astrophys. J., 155: 429-37(Feb. 1969).

Practical formulae for the evaluation of the fluxes due to Compton scattering within discrete sources are derived. These formulae are used to predict the fluxes from M87, the Crab Nebula, M82, Cen A, NGC 1275, and Cas A. The predicted fluxes for certain models of M87, the Crab Nebula, and M82 are found to be above the sensitivities of gamma-ray-detection experiments now in preparation. (auth)

14566 ORIGIN OF THE ANGULAR MOMENTUM OF GALAXIES. Peebles, P. J. E. (Princeton Univ., N. J.). Astrophys. J., 155: 393-401(Feb. 1969).

It is shown that the angular momentum of rotation of the Galaxy agrees in magnitude with the prediction of the gravitational instability picture for the formation of the galaxies. (auth)

14567 GALAXY M82. I. ANALYSIS OF THE OBSERVATIONS. Solinger, Alan B. (Univ. of Michigan, Ann Arbor). Astrophys. J., 155: 403-15(Feb. 1969).

Analysis of the relevant radio and optical data shows that a synchrotron interpretation of the polarized optical continuum observed at large distances from the center of M82 should be ruled out. It is shown that the Hα emission from the filaments is collisionally excited, and that a blast-wave interpretation of the explosion provides a suitable heating mechanism. The observed circular orientation of the electric vectors of the polarized light can be produced by scattering of light from a proposed Seyfert-like nucleus (located at the center of the explosion) by free electrons behind the shock front. The optical luminosity of the nucleus is estimated to be of order 10^{43} ergs sec^{-1} — just about that of a Seyfert nucleus. It is probably obscured by dust. A quantitative development of the model is deferred to a later paper. However, on the basis of the extant data, it is concluded that M82 should be regarded as a Seyfert-like galaxy, seen edge-on. This eliminates two incongruities associated with the galaxy: those of its being the only radio irregular, and only exploding irregular. (auth)

14568 RADIAL DISTRIBUTION OF H II REGIONS IN SPIRAL GALAXIES. Hodge, Paul W. (Univ. of Washington, Seattle). Astrophys. J., 155: 417-27(Feb. 1969).

The distributions of H II regions in twenty-five spiral galaxies are used to establish the general character of the spatial arrangement of these objects. There is generally a peak in the H II region space density at approximately one-fourth the distance from the center to the outermost H II region. Beyond this peak, the H II regions decrease in number approximately exponentially. Interior to this peak they decrease in space density in a way that depends on galaxy type, with slope increasing in the order: Sc, SBc, Sb, SBb. The spiral patterns of the galaxies produce small perturbations on the general pattern. There is good agreement in H II region distribution and the luminosity distribution exterior to the H II peak. The H I distributions for three Sc galaxies disagree greatly with their H II distributions; the H I maximum density lies several times farther from the galaxy center than the H II maximum. (auth)

14569 MOTIONS IN THE PECULIAR GALAXY NGC 5253. Welch, Gary A.; Wallerstein, George (Univ. of Washington, Seattle). Publ. Astron. Soc. Pac., 81: No. 478, 23-32(Feb. 1969).

Observational results are presented of a preliminary spectroscopic study of the emission-line galaxy NGC 5253. The radial velocity of the galaxy is found to be +228 km/sec relative to the galactic center. The presence of lines of moderately high excitation and abnormally large width points to a similarity of NGC 5253 to Seyfert galaxies. Detailed measures reveal that each of the strong lines Hα, N I and N II, and λ 3727 of [O II] is made up of an intense and fairly symmetrical core on which is superimposed a halo showing large velocity dispersion and pronounced asymmetry. The results suggest the presence in the nucleus of a number of emission clouds such as are believed to exist in the nuclei of the Seyfert Galaxies NGC 1068 and NGC 4151. From the distance to NGC 5253, as deduced from the apparent magnitude of the supernova Z Cen and the angular size of the emitting region, it is clear that the emission is not excited by the radiation from Z Cen. (auth)

14570 ISOPHOTAL WAVELENGTHS OF THE U, B, V, AND R SYSTEMS. MacFarlane, Malcolm J. (Univ. of Texas, Austin). Publ. Astron. Soc. Pac., 81: No. 478, 46-50(Feb. 1969).

Isophotal wavelengths of Johnson's U, B, V, and R magnitude systems, determined by comparison with the monochromatic magnitudes of several authors for the color index range $0^m20 \leq (B-V) \leq 1^m20$, of interest in photometry of galaxies are as follows: $\lambda_i(U) = 0.359\ \mu$, $\lambda_i(B) = 0.437 \pm .002\ \mu$, $\lambda_i(V) = 0.544_5 \pm .001\ \mu$, and $\lambda_i(R) = 0.717 \pm .003\ \mu$. (auth)

14571 CLASSIFICATION OF GALAXIES USING THE RECTIFIED IMAGES. Wright, Robert R. (Ohio State Univ., Columbus. Ohio Wesleyan Univ., Delaware). Publ. Astron. Soc. Pac., 81: No. 478, 51-9(Feb. 1969).

The eight galaxies studied are NGC Nos. 2903, 1300, 1398, 5364, 1365, 7741, 613, and 224 (M31). Seven of these galaxies were photographically rectified totally and one (M31) only partially. The galaxies were reclassified, pitch angles were measured, and the angles of inclination were obtained. No galaxy changed more than one classification type and there was no systematic pattern to the changes. The pitch angles were found to decrease with classification type from Sa to Sc. (auth)

Cosmology

Refer also to abstracts 14651 and 15243.

14572 COMMENT ON THIN SHELLS IN GENERAL RELATIVITY. Horsky, J. (Brno Univ.). Phys. Lett., 28A: 379-80 (Dec. 16, 1968).

The special type of space–time matrix is related to a plane matter source. (auth)

14573 ABSOLUTE STABILITY OF MELVIN'S UNIVERSE UNDER NONRADIAL SMALL PERTURBATIONS. Safko, J. L. (Univ. of South Carolina, Columbia). Phys. Lett., 28A: 347-8 (Dec. 16, 1968).

Using the Rainich approach to the combined Einstein–Maxwell problem, Melvin's universe is shown to be stable under all small perturbations in addition to its known stability against radial perturbations. (auth)

14574 SUPERLARGE-SCALE MODEL OF EINSTEIN UNIVERSE. Horak, Z. (Technical Univ., Prague). Phys. Lett., 28A: 332-3(Dec. 16, 1968).

A closed relativistic steady-state model of the Universe consisting of a very large number of oscillating "local universes" is proposed. It creates a nearly constant scalar gravitational potential with average value $-c^2$, is in full agreement with Mach's principle, and is not contrary to astronomical observations. (auth)

14575 COSMIC GAMMA RAYS FROM METAGALACTIC PROTON–ANTIPROTON ANNIHILATION. Stecker, F. W. (Goddard Space Flight Center, Greenbelt, Md.). Nature (London), 221: 425-8(Feb. 1, 1969).

Annihilation gamma radiation has a characteristic spectrum which distinguishes it from other types of cosmic gamma radiation. Such spectra are presented, based on the results of recent accelerator experiments on antiproton annihilation and also including cosmological distortions of local annihilation gamma-ray spectra. (auth)(UK)

14576 INVERSE COMPTON PROCESSES AND THE MICROWAVE BACKGROUND RADIATION. Subbaraman, Madurai Subbier. Ithaca, N. Y., Cornell Univ., 1968. 81p.

This is a study investigating the possibility that the observed isotropic component of the microwave background radiation which has the shape of a 3°-black-body curve may be due to the scattering of very-low-energy photons by high-energy cosmic-ray electrons. The conclusion drawn is that while there exists a theoretical model which could give rise to such a curve, there are serious objections to it which are too formidable to be overcome. (TSS)

14577 THE LOCALLY ISOTROPIC SOLUTIONS OF THE LIOUVILLE AND POISSON EQUATIONS. Ehlers, Juergen; Reinstra, William (Univ. of Texas, Austin). Astrophys. J., 155: 105-16(Jan. 1969).

The general solution (ϕ,f) of the Liouville equation for a collisionless system of gravitationally interacting particles in which the distribution function f is locally isotropic in momentum space is derived. The distribution function is shown to be a spherical distribution in Chandrasekhar's sense. In the nonstationary case, Poisson's equation is solved and is seen to imply a spatially constant density. The stellar orbits are determined, and a class of anisotropic distribution functions which are also compatible with the previously established potential ϕ is constructed. The relation of these solutions to Newtonian cosmology is pointed out. (auth)

14578 KINETIC THEORY OF COSMOLOGY. Bel, L. (CNRS, Paris). Astrophys. J., 155: 83-7(Jan. 1969).

Uniform cosmological solutions are considered for which the model of matter used is that of kinetic theory. Galaxies or clusters of galaxies are regarded as "particles" of the theory. The choice of the distribution function is discussed and the following result is proven: the standard deviation of the red shift is an increasing function of the distance between the source and the observer, provided that this distance is large enough. (auth)

14579 EVOLUTIONARY COSMOLOGIES. A SURVEY. Longair, M. S. (Cambridge Univ., Eng.). Nuovo Cim., Suppl., 6: 990-1001(1968).

In understanding how the Universe has evolved from its earliest stages to the present epoch and the relevant physical processes, important observations and investigations include radio-source counts, quasars with large red shift, cosmic microwave background, reinvestigation of the helium problem, and the background radiation at radio and x ray wavelengths. An attempt is made to show how these observations define in some detail the essential features of evolutionary cosmological models. It is assumed that the quasar red shifts are cosmological. (W.D.M.)

14580 CORRECTIONS IN THE LUMINOSITY–REDSHIFT RELATIONS OF THE HOMOGENEOUS FRIEDMANN MODELS. Kantowski, R. (Southwest Center for Advanced Studies, Dallas). Astrophys. J., 155: 89-103(Jan. 1969).

The bolometric luminosity–red shift relations of the Friedmann dust universes ($\Lambda = 0$) are corrected for the presence of inhomogeneities. The "locally" inhomogeneous Swiss-cheese models are used, and it is first shown that the introduction of clumps of matter into Friedmann models does not significantly affect the R(z) or R(v) relations (Friedmann radius versus the red shift or affine parameter) along a null ray. Then, by the use of the optical scalar equations, a linear third-order differential equation is arrived at for the mean cross-sectional area of a light beam as a function of the affine parameter. This differential equation is confirmed by rederiving its small red-shift solution from an interesting geometrical point of view. The geometrical argument is then extended to show that "mild" inhomogeneities of a transparent type have no effect on the mean area of a light beam. (auth)

14581 CONCERNING THE NATURE OF THE SKY BACKGROUND OF SOFT X-RAY EMISSION. Shklovskii, I. (Sternberg Astronomical Inst., Moscow). Astrophys. Lett., 3: 1-2 (Jan. 1969).

It is proposed that the isotropic background of soft x-ray emission can be explained by emission from galaxies in the lines O(VII)–O(VIII) ($\lambda \approx 20$Å). (auth)

14582 VARIATIONS IN THE COSMIC MICROWAVE BACKGROUND PRODUCED BY NONTHERMAL GRAVITATIONAL RADIATION. Dautcourt, G. (Sternwarte Babelsberg, Potsdam-Babelsberg, Ger.). Astrophys. Lett., 3: 15-18(Jan. 1969).

Interaction of the presumed gravitational background radiation with the microwave background leads to fluctuations in the latter. Due to this effect, measurements by Conklin and Bracewell allow one to impose significant upper limits on the present equivalent mass density of gravitational radiation in the coherence lengths range of 0.3 to 10 Mpc, provided that the intergalactic electron density integrated along the line of sight does not exceed 1.5×10^{24} cm^{-2}. (auth)

14583 ASTROPHYSICAL CONSEQUENCES OF DIRAC'S HYPOTHESIS OF A VARIABLE GRAVITATIONAL NUMBER. Dehnen, H.; Hoenl, H. (Univ., Freiburg i. B.). Astrophys. J., 155: L35-42(Jan. 1969).

Dirac's hypothesis of a variable gravitational number κ leads to astrophysical consequences, which can be verified and which suggest that one interpret the quasi-stellar objects as early stages of normal galaxies. Conversely, one may see in these consequences an indication that the gravitational number κ, according to the new presentation of Dirac's hypothesis by Jordan, Brans, and Dicke, is a function of the age of the Universe and decreases with increasing age of the Universe. (auth)

14584 FINE-STRUCTURE TRANSITIONS AND THE BACKGROUND MICROWAVE RADIATION. Petrosian, Vahe (California Inst. of Tech., Pasadena); Bahcall, John N.; Salpeter, E. E. Astrophys. J., 155: L57-64(Feb. 1969).

The contribution to the background microwave radiation from decays of excited fine-structure states of the more abundant ions is calculated. Transitions occurring in the Galaxy, in distant galaxies, and in the intergalactic medium are considered. It is shown that the intensity of radiation from fine-structure transitions in the Galaxy and in nearby galaxies exceeds the intensity of a 2.7°K black body for wavelengths less than 0.05 cm. (auth)

14585 DISTRIBUTION OF BLACKBODY CAVITY RADIATION IN A MOVING FRAME OF REFERENCE. Henry, G. R.; Feduniak, R. B.; Silver, J. E.; Peterson, M. A. (Stanford Univ., Calif.). Phys. Rev., 176: 1451-5(Dec. 25, 1968).

Blackbody cavity radiation is considered from the point of view of an observer in arbitrary uniform motion with respect to the c.m. of the radiation. It is found that the only effect of the motion is to introduce an angle-dependent effective temperature, which replaces the rest-frame temperature of the cavity. The results are applied to the question of the earth's motion through the 3°K cosmic radiation. (auth)

14586 STATIC, AXIALLY SYMMETRIC POINT HORIZONS. Winicour, Jeffrey; Janis, Allen I.; Newman, Ezra T. (Univ. of Pittsburgh). Phys. Rev., 176: 1507-13(Dec. 25, 1968).

Properties of event horizons are examined for static, axially symmetric, vacuum space–times. Israel has shown that under fairly general conditions such horizons are singular. One would expect that a positive-mass point particle would correspond to a pointlike singular horizon. It is shown, however, that the horizon cannot be pointlike. The geometry of particular horizons is discussed. (auth)

14587 INVERSE COMPTON EFFECT AND UNIVERSAL 3°K RADIATION. Oster, Ludwig (Univ. of Colorado, Boulder). Phys. Rev., 176: 1501-5(Dec. 25, 1968).

The production of photons with energies in the range where at present the 3° blackbody radiation is observed from less-energetic radio photons of galactic and metagalactic origin was investigated. It is shown that this process cannot contribute significantly to the observed intensity. At an earlier stage of the development of the Universe, Compton events were probably much more frequent. However, since under plausible assumptions on the energy distribution of cosmic-ray electrons Compton scatterings do not produce a blackbody spectrum, the results can be used to establish an upper limit for the density of relativistic electrons and radio photons at the time of original galaxy formation. (auth)

14588 UPPER LIMITS TO THE INTENSITY OF BACKGROUND RADIATION AT $\lambda = 1.32$, 0.559, AND 0.359 mm. Bortolot, V. J. Jr.; Clauser, J. F. (Columbia Univ., New York). Phys. Rev. Lett., 22: 307-10(Feb. 17, 1969).

From observations of interstellar optical absorption lines of CN, CH, and CH^+ one is able to impose upper limits, at three wavelengths, on the intensity of background radiation in the interstellar medium. These limits are consistent with the existence of thermal background radiation at a temperature of ~3°K, but can be reconciled with the results of a recent rocket observation by Shivanandan, Houck, and Harwit only if the intense flux which they report is concentrated into a sharp line which happens to avoid the molecular resonances, or if this flux is of local origin. (auth)

14589 OBSERVATIONS IN SOME SIMPLE COSMOLOGICAL MODELS WITH SHEAR. Saunders, P. T. (Queen Elizabeth Coll., London). Mon. Notic. Roy. Astron. Soc., 142: 213-27 (1969).

Homogeneous but anisotropic models of Bianchi type I with the two distinct forms of singularity, the "pancake" and "cigar", are considered in some detail. It is found that in some directions of observation neither the redshift nor the luminosity distance is a monotonic function of the emission time. Some numerical examples are given and possible consequences with regard to the selection of world models and the problem of quasars are discussed. (auth) (UK)

14590 ON THE ROTATION OF THE UNIVERSE. Hawking, Stephen (Inst. of Theoretical Astromony, Cambridge, Eng.). Mon. Notic. Roy. Astron. Soc., 142: 129-41(1969).

The possibility that the Universe could possess a large scale, homogeneous vorticity is discussed. The limit that can be placed on the value of this vorticity from the present observations of the microwave background is between 10^{-14} and 7×10^{-17} rad yr^{-1} if the Universe is spatially closed and about 2×10^{-46}/(present density in g cm^{-3}) rad yr^{-1} if it is open. If the observations were extended over the whole sky it might be possible to decide whether, in fact, the Universe is open. It is also shown that viscosity tends to reduce vorticity though not sufficiently to produce the present limits from arbitrary initial conditions unless the present density has the very low value of 2.5×10^{-33} g cm^{-3}. (auth) (UK)

14591 SOLUTIONS TO THE VLASOV EQUATION FOR NEWTONIAN COSMOLOGIES. Mjolsness, Raymond C. (Pennsylvania State Univ., University Park). Astrophys. J., 155: 697-9(Feb. 1969).

It is shown that the average dynamics of isotropic Newtonian cosmological models is unaffected by the use of a particle distribution function which is compatible with the symmetry of the model but which is otherwise arbitrarily anisotropic. Simple expressions are found for the time dependence of all velocity moments of the distribution function. (auth)

14592 ON THE DETERMINATION OF THE SLOPE FROM RADIO-SOURCE COUNTS. Refsdal, Sjur (Univ. of Nebraska, Lincoln. Univ. of Oslo). Astrophys. J., 155: 373-8(Feb. 1969).

A method is demonstrated by which the uncertainty in the slope, due to the statistical scattering in the number of sources, can be determined. Existing data are used to compare the method with other known methods, some of which are shown to be statistically incorrect. The approximations that are used assume that the number of sources is large. The method seems to represent a reasonable compromise between statistical correctness and numerical simplicity. (auth)

14593 COSMOLOGIES OF BIANCHI TYPE I WITH A UNIFORM MAGNETIC FIELD. Jacobs, Kenneth C. (California Inst. of Tech., Pasadena). Astrophys. J., 155: 379-91(Feb. 1969).

An analysis is presented of the effects of a uniform, primordial magnetic field upon spatially homogeneous cosmological models with the anisotropic, Euclidean metric $ds^2 = dt^2 - A^2(t)dx^2 - B^2(t)dy^2 - W^2(t)dz^2$. The stress-energy tensor consists of perfect-fluid matter with the equation of state $p_M = \gamma\rho_M$ ($0 \leq \gamma \leq 1$) and a uniform magnetic field of energy density ρ_B. Analytical solutions are obtained for four subcases, and all remaining cases are studied by numerical integration. Axisymmetric solutions (A = B) always emerge from point or pancake singularities, while nonaxisymmetric solutions ($A \neq B$) always emerge from initial cigar or barrel singularities. The solutions are used in a cursory examination of the effects of a primordial magnetic field upon (a) the temperature isotropy of the observed 3°K cosmic microwave radiation, (b) the time when expansion anisotropies become small, and (c) primordial element formation. (auth)

14594 MEASURABLE EFFECT OF GENERAL RELATIVITY IN SATELLITE ORBITS. Gaposchkin, E. M.; Wright, J. P. (Smithsonian Astrophysical Observatory, Cambridge, Mass.). Nature (London), 221: 650(Feb. 15, 1969).

Since transmitting oscillators (clocks) in close Earth satellites will run at different rates in different potential fields, the calculated Doppler velocity attributed to the satellite will be different depending on whether Newtonian or relativistic (Einsteinian) theory is used to reduce the data of one-way Doppler satellites, such as in TRANET navigation observations. This effect will not occur for two-way Doppler satellites, and one-way and two-way Doppler data should differ by the relativistic effect. An expression is given, in the framework of Einstein's theory, for the ratio of the observed frequency to the standard frequency on the Earth (for a symmetrical Earth). This expression includes the special relativistic transverse Doppler effect. In practice the nonsphericity of the Earth's potential is included in the reduction, and the rate of the Earth clock will depend on the potential at the station. The expression mentioned is rewritten in terms of orbital parameters, and the resulting expression is separated into two parts—a constant term indistinguishable from a zero set error in the oscillator frequency, and a term which is multiplied by the eccentricity and has a period of one revolution. The Doppler data can be obtained to an accuracy of 1 to 2 cm/s with a two-frequency system, which removes ionospheric effects. With improved orbit calculations it should be possible to use these considerations to establish the validity of relativity. (UK)

Planetary Phenomena

14595 VENERA-4 AND INTERPRETATION OF RADIO-ASTRONOMICAL MEASUREMENTS OF VENUS. Kuz'min, A. D.; Vetukhnovskaya, Yu. N. Kosm. Issled., 6: 590-7(July-Aug. 1968). (In Russian).

The results of AMC measurements (Venera-4) are used for interpretation of ground radio-astronomical observations. The radio-astronomical data agree with the model of the atmosphere of Venus, constructed according to the Venera-4 AMC data. Water and water vapor contents in the Venusian atmosphere are estimated. Certain premises concerning possible physical conditions on Venus are expressed. (tr-auth)

14596 RADIATIVE TRANSFER BY DOUBLING VERY THIN LAYERS. Hansen, James E. (Goddard Space Flight Center, New York). Astrophys. J., 155: 565-73(Feb. 1969).

A doubling principle first used by van de Hulst was developed to provide rapid and accurate results for the problem of diffuse reflection from a plane-parallel atmosphere. The method described here eliminates the need for numerically solving an equation of radiative transfer by beginning with a layer of such small optical thickness ($\tau \sim 2^{-25}$) that the initial scattering and transmission functions are given by the phase function. An application is made to spectral scattering by clouds in the visual and near-infrared, where the phase function is strongly peaked in the forward direction. (auth)

14597 ON SOLUTIONS OF AN EQUATION OF TRANSFER FOR A PLANETARY ATMOSPHERE. Mourad, S. A.; Siewert, C. E. (North Carolina State Univ., Raleigh). Astrophys. J., 155: 555-64(Feb. 1969).

A set of general solutions to the homogeneous vector equation of transfer for the two azimuth-independent components of a partially plane-polarized radiation field is obtained. In addition to describing the scattering of light by anisotropic particles, the model considered here is appropriate for the quantum theory of resonance line scattering. The analysis, which is based on Case's method of normal modes, yields two discrete eigenvectors and two linearly independent, degenerate, singular, continuum eigenvectors. A full-range completeness theorem for the aforementioned eigenvectors is proved by solving two coupled singular integral equations. Further, a full-range orthogonality theorem is proved, the necessary normalization integrals are determined, and the full-range adjoint vectors are constructed. (auth)

Atomic and Molecular Physics

Refer also to abstracts 13974, 14424, 14431, 14433, 14434, 14523, 14530, 14532, 14548, 14859, 14925–14927, 15026, 15066, 15212, 15321, 15300, 15467, and 15495.

14598 (AECL–3200) ATOMIC WAVE FUNCTIONS. Winterbon, K. B. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Nov. 1968. 31p. Dep. CFSTI. CAN $1.00.

The parameters of some of the atomic wave functions calculated by Clementi have been punched on cards. APEX programs exist for using these data in calculations. The ions are those with $Z \leq 29$, and $n_0 \leq n \leq Z + 1$, where n is the number of electrons, and n_0 the larger of 0 and Z–10. The explanatory text published with Clementi's tables is reprinted, with permission, and two tables of radii of the various wave functions are given. The radii are defined in different ways and are very different. (auth)

14599 (ANL–Trans–710) SLOW INELASTIC COLLISIONS BETWEEN ATOMS. Takayanagi, Kazuo. Translated by M. Inokuti (Argonne National Lab., Ill.), from Nippon Butsuri Gakkaishi, 21: No. 9, 626-32(1966). 25p. Dep. CFSTI.

A pair of electronic states that differ in energy by a finite amount at infinite separation change as the internuclear distance gradually decreases; the so-called adiabatic potentials may approach each other very closely or may intersect with each other within a certain approximation. The probability of a transition between electronic states in this situation may be evaluated through a formula derived in 1932 by Landau and by Zener. Some recent developments in connection with this formula are reviewed in this article. Questions concerning the validity of the assumptions made in derivation of the formula and the range of applicability of the formula are considered. (A.G.W.)

14600 NEW X-RAY DIAGRAM LINES IN THE L SPECTRUM OF Tb. Deodhar, G. B.; Varma, P. P.; Singh, R. B. (Univ. of Allahabad, India). Can. J. Phys., 47: 341-3(Feb. 1, 1969).

In an experimental investigation of the L-emission spectrum of terbium, the existence of the quadrupole lines λλ1711.99, 1552.87 x.u. corresponding to the transitions $L_{III}N_{III}$ and $L_{II}N_{III}$ respectively, the nonquadrupole line λ1427.12 x.u. corresponding to the transition L_IO_I, and the octupole line λ1765.13 x.u. due to the transition $L_{II}M_V$ has been established for the first time. Also, the dipole lines $L_{II}O_I(\gamma_8)$, $L_{II}O_{IV}(\gamma_6)$, and $L_{III}O_{IV,V}(\beta_8)$ and the quadrupole line due to the transition $L_IO_{IV,V}$ reported so far only by Sakellaridis have been confirmed. However, the line $L_{II}M_I(\eta)$ also reported by Sakellaridis could not be confirmed. (auth) (CANADA)

14601 RANGES OF NITROGEN IONS IN Al, Ni, Ag, AND Au. Nakata, H. (Kyoto Univ.). Can. J. Phys., 46: 2765-70(Dec. 15, 1968).

Energy-loss curves for ^{14}N ions passing through Al, Ni, Ag, and Au have been observed at $E(^{14}N) = 1$ to 12 MeV, and the range–energy relations have been obtained. The present results are a little lower than the theoretical values. This is partly due to the fact that the parameters k and μ are large in these cases. (auth) (CANADA)

14602 CONVOLUTION, DECONVOLUTION, AND SMALL-ANGLE PLURAL ELECTRON SCATTERING. Misell, D. L.; Burge, R. E. (London Univ.). J. Phys., C (London), 2: 61-7 (Jan. 1969).

A method is given for the evaluation of two-dimensional small-angle folding integrals in the particular case of cylindrical symmetry. The associated problem of deconvolution of scattering patterns with cylindrical symmetry is also considered. The results are particularly applied to problems in the small-angle scattering of electrons (incident energy range 20 keV to 1 MeV). The accuracy of the method of computation is illustrated by calculating the angular distribution of electrons after ten scattering events using a test first-scattering distribution of Gaussian form. The general procedure also allows correction of the electron-scatter patterns for convolution effects due to the finite angular divergence of the incident electron beam and the finite size of the collector aperture. (auth)(UK)

14603 MASS ANALYSIS OF IONS PRODUCED BY HYPERVELOCITY IMPACT. Hansen, D. O. (Thompson Ramo Wooldridge Inc., Redondo Beach, Calif.). Appl. Phys. Lett., 13: 89-91 (Aug. 1, 1968).

Ions resulting from the impact of hypervelocity microscopic particles upon a solid Ta target were analyzed by time-of-flight techniques. The impact velocity of the micron-size and smaller, predominately iron particles (~98% Fe) ranged from 2 to 45 km/sec, which corresponds to an energy range of from 1 to 600 eV/atom. The kinetic energy of the particles is converted into internal energy of an expanding, partially ionized vapor cloud composed of both target and particle material. The energy conversion process occurs on a time scale comparable to that involved in the Q-switched laser beam–solid target interactions. In addition to ions of both the bulk target and particle materials, a number of other ion groups are observed which are presumed to be impurities from both the particle and target. A tentative model describing the process is discussed. (auth)

14604 ENERGY AND ANGULAR DISTRIBUTIONS OF SECONDARY ION EMISSION. III. ANGULAR DISTRIBUTION AND ION YIELDS. Hennequin, Jean-Francois (CNRS, Orsay, France). J. Phys. (Paris), 29: 957-68(Oct. 1968). (In French).

Part of an experimental study is presented on the emission of secondary positive ions from metallic targets during bombardment by ions of noble gases having an energy of a few keV. The angular distribution and the yield of ions emitted by some metals (Mg, Al, Si, Ti, Fe, Ni, Cu) have been established under different conditions of bombardment. A kinetic mechanism of secondary ion emission which could be deduced from the results is then discussed. (auth)

14605 PROCESS FOR PRODUCING NEGATIVE HYDROGEN IONS. Donnally, Bailey L. (to Lake Forest Coll.). U. S. Patent 3,424,905. Jan. 28, 1969. Filed Apr. 25, 1966.

Negatively charged hydrogen ions may be produced by passing a beam of relatively low-energy protons (e.g., in the range of up to several kiloelectron volts) through the vapor of an alkali atom. It is believed that the negative hydrogen ions are produced from ground-state hydrogen atoms, which in turn are derived from the protons via metastable intermediates. In particular, it is believed that the beam of protons is converted into ground-state hydrogen atoms by first converting the beam of protons into metastable hydrogen atoms, which are quenched by collision to ground state. A second possible means for such conversion involves converting the beam of protons into hydrogen atoms, the electrons of which are in the 2p level and other excited states, which atoms spontaneously decay directly to the ground state. Since the various conversions are all achieved by interaction of the particle and an alkali atom, the entire conversion process may be carried out using the same alkali atom in a single collision region. (auth) (Offic. Gaz.)

14606 HARTREE EIGENVALUE FOR HELIUM. Zink, J. W. (Univ. of California, Livermore). Amer. J. Phys., 36: 844(Sept. 1968). (UCRL–70310(Rev.5)).

The physical reason for the unexpectedly close agreement between the eigenvalue for He obtained by the self-consistent field (SCF) method and the negative of the ionization potential is pointed out. A difference is expected because the SCF orbitals for the atoms and hydrogenic orbital for singly ionized He are very different. A calculation of the expectation values for the kinetic and potential energies shows that the expectation value of the potential energy is considerably larger with a SCF orbital than with a hydrogenic orbital, while the expectation value of the kinetic energy is considerably smaller. The total of the two values, which is used in the eigenvalue calculation, is thus very nearly equal for both orbitals. (A.G.W.)

14607 PROCESS FOR PRODUCING NEGATIVE HYDROGEN IONS FROM PROTONS. Donnally, Bailey L. (to Lake Forest Coll.). U. S. Patent 3,424,904. Jan. 28, 1969. Filed May 3, 1965.

A beam of relatively low-energy negatively charged hydrogen ions may be obtained by passing a beam of relatively low-energy (e.g., up to about 2000 electron volts) protons through atoms of an alkali metal in order to produce a beam of particles containing metastable and ground-state hydrogen atoms and charged particles. Thereafter, charged particles are deflected from the beam, and the beam (which contains metastable and ground-state hydrogen atoms) is passed through a region containing a gas having an ionization energy of at least about 11.0 and preferably at least about 14.0 electron volts in order to selectively negatively ionize the metastable hydrogen atoms in preference to ground-state atoms. By subjecting the beam to a magnetic field of sufficient strength to polarize the metastable hydrogen atoms prior to negative ionization, and by conducting the negative ionization step in a weak magnetic field region, the nuclei of the negatively charged hydrogen ions produced are polarized. (auth) (Offic. Gaz.)

14608 ELECTRON SCATTERING OF ALKALI METAL ATOMS CONSIDERING THE LONG-RANGE FORCES. Damburg, R. Ya.; Karule, E. M. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser., No. 5, 17-20(1968). (In Russian).

Long-range force effects on the elastic-scattering phase of alkali metals were studied. Phases for K and Na were calculated in a modified strong-coupling approximation, suggested earlier, considering the fundamental and the first two excited states. Together with the first excited p state for $L \leq 2$, the long- as well as the short-range potentials should be taken into account. The first-excited s state exercises a minor effect on the phase value in comparison to the p state. The scattering lengths for K and Na were calculated by means of the strong-coupling method. (auth)

14609 INFLUENCE OF THE DIPOLE–QUADRUPOLE DISPERSION FORCES ON THE TOTAL COLLISION CROSS SECTION BETWEEN ATOMS AND POLARIZED DIATOMIC MOLECULES. Reuss, J. (Univ., Nijmegen, Netherlands). Physica, 34: 413-25(1967).

The effects of the angle-dependent dipole–quadrupole dispersion forces are investigated for heavy collision partners. The parameters, giving the strength of the angle-dependent potential terms, are estimated by use of the Drude model. The Landau and Lifshitz approximation leads then to explicit expressions for the state-dependent part of the total collision cross section, in first order of these asymmetry parameters. (auth)

14610 RADIATION SPECTRUM OF NITROGEN PARTICLES AFTER COLLISIONS WITH ELECTRONS. Hartnagel, H.; Slater, M. B. (Univ. of Sheffield, Eng.). Physica, 34: 426-8 (1967).

The visible spectrum of nitrogen particles after collision with the electrons of a high-density beam has been measured at a pressure of 10^{-4} torr. It is found that the bands of the second positive and the first negative system are present. (auth)

14611 INELASTIC ENERGY LOSSES IN COLLISIONS OF 40 TO 90 keV Ar^+ IONS WITH SOLID AND GASEOUS Cu TARGETS. Snoek, C.; Van Der Weg, W. F.; Geballe, R.; Rol, P. K. (FOM-Instituut voor Atoom- en Molecuul Fysica, Amsterdam). Physica, 35: 1-18(1967).

Large-angle scattering of 40-, 60-, and 90-keV Ar^+ ions against Cu atoms is studied. Both free atoms and atoms situated at the surface of a solid are used as target atoms. The inelastic energy losses are derived from the scattering angles and the kinetic energies of the scattered ions. The inelastic losses initially increase with increasing center-of-mass scattering angle and reach plateau values of about 850, 1100, and 1300 eV for primary energies of 40, 60, and 90 keV, respectively. It is found that the physical state of the target has no noticeable influence on the result of these measurements. The inelastic energy losses measured at a given primary energy and scattering angle show a distribution around an average value. The half-width of this distribution is found to be in the order of 50% of the average inelastic energy loss, independent of the kinetic energy of the incoming ion. (auth)

14612 COLLISION-INDUCED DISSOCIATION OF 10-keV H_2^+ IONS. Gibson, D. K.; Los, J. (FOM-Instituut voor Atoom-en Molecuulfysica, Amsterdam). Physica, 35: 258-72(1967).

Measurements of the angular and velocity distributions of the protons obtained by passing a beam of 10-keV H_2^+ ions through hydrogen or helium gases are described. The angular distribution is in agreement with that previously measured by McClure. The velocity distribution has been accounted for in terms of collision-induced electronic excitations leading to dissociative states of the H_2^+ ion. The agreement between theory and experiment indicates that this theory is essentially correct, the greater unknown being the dependence of the excitation cross section upon the length and orientation of the H_2^+ internuclear axis. This dependence is found to be different for the two target gases (H_2 and He). (auth)

14613 ADDENDUM TO "VARIATIONAL BOUNDS IN POSITRON–ATOM SCATTERING." Drachman, Richard J. (Goddard Space Flight Center, Greenbelt, Md.). Phys. Rev., 179: 237-9 (Mar. 5, 1969).

Two additional positron–atom processes are treated using previously determined [Phys. Rev., 173: 190(1968)] variational scattering functions: (1) Positronium formation in e^+–H collisions at threshold, and (2) the angular correlation between e^+–He annihilation quanta at zero energy. In case (1), a large reduction below the Born approximation is found, in qualitative agreement with other recent theoretical work. In case (2), very close agreement is found with the experiment of Briscoe et al. (auth)

14614 DIABATIC AND ADIABATIC REPRESENTATIONS FOR ATOMIC COLLISION PROBLEMS. Smith, Felix T. (Stanford Research Inst., Menlo Park, Calif.). Phys. Rev., 179: 111-23 (Mar. 5, 1969).

The equations of the general Born–Oppenheimer separation into electronic and heavy-particle coordinates are reexamined, and the coupled equations that result for the heavy-particle motion are expressed in a particularly simple form. This is accomplished by introducing a generalized matrix operator for the effective momentum associated with the heavy particles; the matrix portion of this operator represents a coupling of the nuclear momentum with the electronic motion. The commutator between the momentum and potential matrices is a force matrix, which provides an alternative means of evaluating the momentum matrix. The momentum coupling has both radial and angular parts; the angular momentum coupling agrees with Thorson's expression. In the usual adiabatic molecular representation, the potential energy matrix is diagonalized, and all the coupling is thrown into the radial- and angular-momentum matrices. For collision problems it is often more important to diagonalize the radial-momentum matrix, putting the radial off-diagonal coupling into the potential matrix; this generates a family of diabatic representations, the most important of which dissociates to unique separated atom states. This standard diabatic representation has the properties called for by Lichten, is uniquely defined even with the inclusion of configuration interaction, and leads immediately to the Landau–Zener–Stueckelberg limiting case under appropriate conditions. (auth)

14615 ASYMPTOTIC FORM OF THE TOTAL WAVE FUNCTION FOR ELECTRON-IMPACT EXCITATION OF HYDROGEN ATOMS. Kang, Ik-ju (Southern Illinois Univ., Carbondale). Phys. Rev., 179: 101-4 (Mar. 5, 1969).

An asymptotic form of the total wave function for electron-impact excitation of hydrogen atoms is obtained by the use of the Coulomb Green function. The result is compared with the corresponding usual form, obtained through the free-particle Green function. The validity of the Coulomb wave formulation is upheld in view of the physical quantities being finite definite. (auth)

14616 IONIZATION OF POSITIVE IONS. Thomas, Brian K. (Univ. of Pittsburgh); Garcia, J. D. Phys. Rev., 179: 94-101 (Mar. 5, 1969).

The classical binary-encounter model for ionization by charged-particle impact is modified to permit evaluation of the cross section for ionization of positive ions by electron impact. General scalable expressions are obtained and compared with available experimental data and quantum-theoretical approximations. The dependence on ionic charge is discussed, and a simple physical interpretation emerges. The results indicate that this model is nearly as reliable as the Born approximation for this process; i.e., they agree well with existing experimental data for energies much larger than threshold and are everywhere within a factor of two. (auth)

14617 COMPACT OPERATORS AND PARTICLE–BOUND-STATE SCATTERING: ONE-CHANNEL CASE. Payne, G. (Univ. of Iowa, Iowa City). Phys. Rev., 179: 85-94 (Mar. 5, 1969).

A method for treating particle–bound-state scattering problems is developed, which is based on compact operators. The computations necessary are similar to those of variational methods. Being based on compact operators, the method is not subject to the breakdowns that plague variational methods. The method is applied to triplet s-wave electron–hydrogen scattering with excellent results. Hulthén's principle can be examined by our analysis and, for one set of basis functions, justified. A simple criterion is obtained for recognizing when results following from the Hulthén principle will be unreliable and a manner of applying Hulthén's principle is indicated, which always leads to reliable results. (auth)

14618 PHASE-SHIFT CALCULATION FOR LOW-ENERGY ELECTRON–Rb SCATTERING. Balling, Ludwig C. (Univ. of New Hampshire, Durham). Phys. Rev., 179: 78-84 (Mar. 5, 1969).

Total elastic and total spin-exchange cross sections have been calculated numerically for low-energy electrons incident on rubidium atoms. The effects of electron exchange and of target distortion are treated through the use of the adiabatic exchange approximation and the method of polarized orbitals. (auth)

14619 EXTENSION OF THE INTEGRAL FORMULATION OF SCATTERING THEORY TO COULOMB INTERACTIONS. Altick, P. L. (Univ. of Chicago). Phys. Rev., 179: 71-8 (Mar. 5, 1969).

The integral formulation of scattering theory is extended to the treatment of a residual interaction with a Coulomb tail. The approach involves expanding the Green's function in a basis set and then finding the proper analytical treatment of the familiar pole as well as of other singularities in the kernel that are peculiar to long-range interactions. The pure Coulomb case is given as an example of the formulation. Methods of reducing the integral equations to an algebraic set are given for a residual interaction

with arbitrary short-range form and a Coulomb tail. Finally, the extension of this procedure to many channels is described. (auth)

14620 ANOMALY-FREE VARIATIONAL METHOD FOR INELASTIC SCATTERING. Nesbet, R. K. (IBM Research Lab., San Jose, Calif.). Phys. Rev., 179: 60-70 (Mar. 5, 1969).

Analysis, given in an earlier paper, of standard variational methods for elastic scattering is extended to the case of several open channels. As in the case of elastic scattering, and contrary to widespread expectation, the spurious singularities inherent in the Kohn formalism are shown, for the general multichannel case, not to arise from the singularities of the linear inhomogeneous system of equations common to standard variational methods. The Kohn formula for elements of the R or K matrix, and its analog for the R^{-1} matrix, are shown to vary smoothly, without poles, as the energy parameter goes through eigenvalues of this system of equations. The spurious singularities arise from isolated zeroes of determinants that occur in the denominator of the Kohn formula and of its analog (the inverse Kohn formula) for R^{-1}. The singularities in these formulas do not in general coincide, and a criterion is proposed for alternative use of these formulas, resulting in a procedure free of spurious singularities. This analysis is illustrated by calculations on a soluble two-channel-model problem. An incidental result of the present formalism is a proof that the approximate R matrix given by the Kohn formula is symmetric and real if the basis functions used are real. (auth)

14621 EXCITATION OF 3914 A N_2^+ RADIATION IN COLLISIONS OF HEAVY IONS WITH N_2. Kurzweg, L.; Lo, H. H.; Brackmann, R. T.; Fite, W. L. (Univ. of Pittsburgh). Phys. Rev., 179: 55-9 (Mar. 5, 1969).

The cross sections for production of the (0,0) transition of N_2^+ first negative bands (3914 Å) produced in collisions of several heavy ions with N_2 have been measured. The ions used were Ba^+, Ba^{2+}, Xe^+, N^+, O^+, and N_2^+ in the energy range from approximately 50 keV to 2 MeV. Absolute cross sections were determined by comparing signals produced on ion impact with those produced by an electron beam passing through the gas cell and using the known electron-impact excitation cross sections. Signals were detected using an interference filtered photomultiplier. The results are compared with those of other investigators where such other results exist. (auth)

14622 PAULI-PRINCIPLE RESTRICTION ON THE TWO-MATRIX OF BOPP FOR ATOMIC GROUND STATES. Kijewski, L. J.; Percus, J. K. (New York Univ., N. Y.). Phys. Rev., 179: 45-54 (Mar. 5, 1969).

A lower bound to the ground-state energy of an atom is formulated, using the pair density matrix $\Gamma^{(2)}$. The major problem in the development of such methods is that of finding necessary conditions on $\Gamma^{(2)}$ not satisfied by the current optimal class of density matrices. It is shown that the Bopp two-matrix ansatz suffers mainly from failure to satisfy the Pauli principle. With the aid of an extensive set of system-dependent identities for $\Gamma^{(2)}$, numerical computations indicate how energy improvement will follow from insistence on the Pauli principle. A new necessary condition is conjectured, which combines the Pauli condition on $\Gamma^{(1)}$ with a maximum eigenvalue condition on $\Gamma^{(2)}$. (auth)

14623 DIFFICULTIES OF THE INDEPENDENT-PARTICLE MODEL IN THE DESCRIPTION OF ENERGETIC TRANSITIONS IN ATOMS. Hameed, S. (Univ. of Manchester, Eng.). Phys. Rev., 179: 16-19 (Mar. 5, 1969).

It is shown that the first-order correlation correction to the transition matrix element between two nonpenetrating states can be written in a completely parametrized form. The correction is directly proportional to the square of the transition energy and to the dipole polarizability of the core. It follows that for sufficiently energetic transitions the magnitude of the correction becomes as large as the zero-order matrix element. (auth)

14624 RADIATIVE DECAY RATES OF VACANCIES IN THE K AND L SHELLS. Scofield, James H. (Univ. of California, Livermore). Phys. Rev., 179: 9-16 (Mar. 5, 1969).

A calculation is made of the rates of emission of x rays in the filling of vacancies in the K and L shells. The total radiative decay rates and the rates of emission of a number of x-ray lines are presented for a range of elements. The atomic electrons are taken to be in single-particle states in a central potential given by the relativistic Hartree–Slater theory. All multipoles of the radiation field and all transitions from occupied states of the atom are included. The electrons are treated relativistically and the effect of retardation is included. (auth)

14625 ELECTRON-IMPACT BROADENING OF OVERLAPPING He I LINES PLASMAS. Deutsch, C. (Laboratoire de Recherches Physiques, Paris); Herman, L.; Drawin, H.-W. Phys. Rev., 178: 261-70 (Feb. 5, 1969).

The general impact theory of electron broadening, developed previously by Griem, Baranger, Kolb, and Oertel (GBKO), is extended in order to take into account the off-diagonal matrix elements necessary to treat the case of partially overlapping lines. The new time integrals arising in the theory have rigorously been evaluated. It follows a generalized and consistent treatment of overlapping lines for any degree of degeneracy. The "complete degeneracy case" (hydrogen) and the "isolated-line case" appear as limiting situations in the theoretical description. In order to describe the four possible kinds of second-order atomic transitions, one is led to generalize the A and B functions of GBKO. Properties of these new A (z_1,z_2) and B (z_1,z_2) functions are considered in detail. (auth)

14626 CONVERSION $^3S \rightarrow {}^1S$ OF POSITRONIUM IN THE ICE-WATER SYSTEM. Iaci, G.; Lo Savio, M. (Univ., Catania, Italy). Phys. Lett., 28A: 458-9 (Dec. 30, 1968).

A new suggestion is made to explain the behavior of the positronium annihilating in ice. (auth)

14627 PRESSURE DEPENDENCE OF RADIATIVE PROCESSES IN HELIUM. Guazzoni, P.; Pignanelli, M. (Univ., Milan). Phys. Lett., 28A: 432-3 (Dec. 30, 1968).

The radiative processes in helium are studied. The role of atomic metastable states and of He_2^+ ions is determined. (auth)

14628 ORTHOPOSITRONIUM LIFETIMES AND THE NATURE OF THE 10^{-8}-SEC LIFETIME OBSERVED IN OXIDES. Sen, P.; Patro, A. P. (Saha Inst. of Nuclear Physics, Calcutta). Phys. Lett., 28A: 414-15 (Dec. 30, 1968).

Experiments in support of the two-photon nature of the 10^{-8}-sec lifetime and the presence of a 1.4×10^{-7}-sec lifetime corresponding to the three-photon decay in oxides are presented. (auth)

14629 BACKSCATTERING OF DEUTERIUM IONS IN TITANIUM. McCracken, G. M. (United Kingdom Atomic Energy Authority, Abingdon, Eng.); Freeman, N. J. Phys. Lett., 28A: 415-16 (Dec. 30, 1968).

Good agreement is obtained both in form and absolute magnitude between the measured energy distribution of keV deuterons backscattered from a titanium target and the values calculated from a model based on a single large-angle scattering event. (auth)

14630 FINAL-STATE DISTORTION EFFECTS IN AUTOIONIZATION OF THE $^4P_{5/2}$ STATE OF He^-. Estberg, G. N. (Univ. of San Diego, Calif.); LaBahn, R. W. Phys. Lett., 28A: 420-1 (Dec. 30, 1968).

The lifetime of the 1s 2s 2p $^4P_{5/2}$ state of He^- is calculated, including the effects of distortion to the final state of the atom by the continuum electron. A reduction of the lifetime from 3×10^{-4} sec to 2.66×10^{-4} sec is obtained from inclusion of distortion. (auth)

14631 DIRECT COMPARISON OF POSITRON AND ELECTRON RANGES IN RARE EARTH METALS AND OTHER SOLIDS. Takkar, P. S. (Royal Military Coll., Kingston, Can.). Phys. Lett., 28A: 423-4 (Dec. 30, 1968).

The penetration of 1.88-MeV positrons and 1.77-MeV electrons in the rare earth metals including yttrium, neodymium, holmium, and ytterbium foils show much larger positron–electron differences in their comparative ranges than the rest of the solids including C, Al, Cu, Sn, and Pb. These are the first such measurements for rare earth metals. The ratio of ranges r^-/r^- for rare earths is comparable to some liquids such as water, benzene, toluene, and methyl alcohol. (auth)

14632 PULSED SOURCE FOR HEAVY, SHORT-DURATION ELECTRON CURRENTS. Bugaev, S. P.; Zagulov, F. Ya.; Kobal'chuk, B. M. Mesyats, G. A. (Tomsk Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 1, 145-7 (1968). (In Russian).

A source was developed for short (10 to 100 nsec) electron pulses with an amplitude of 2×10^3 amp. Its performance is based on the extraction of electrons from discharge plasma in vacuum. A unique plasma cathode design made it possible to obtain an electron current density of 200 A/cm². The source proposed by the authors provides for a uniform distribution of the discharge plasma over a large surface of the cathode. For this purpose, the electrode system consists of a corrugated metallic mesh on a substrate with a high dielectric constant. The opposite side of the substrate is cooled with a metallic film. The thickness of the substrate, the dielectric constant, and the pitch of the mesh are selected so as to produce an optimum configuration of internal capacitances for the breakdown distribution. The

design allows for the formation of emitting surfaces of any configuration and for increasing the area of these surfaces without changing the density of the current. (ATD)

14633 ELECTRON SPIN POLARIZATION BY LOW-ENERGY SCATTERING FROM UNPOLARIZED TARGETS. Kessler, J. (Univ., Karlsruhe, Ger.). Rev. Mod. Phys., 41: 3-25(Jan. 1969).

The status of theory and experiment of electron polarization resulting from spin–orbit interaction in low-energy scattering from unpolarized targets is reviewed. Polarization effects in scattering from free atoms, molecules, and solid targets at energies between a few electron volts and a few thousand electron volts are discussed. Apart from a survey of the problems that have been solved, a perspective is given of the work that would be interesting to pursue in this rapidly developing field of research. (auth)

14634 EFFECT OF ELECTRON SOURCE TO ENERGY RESOLUTION IN ELECTRON VELOCITY ANALYSIS: INTERPRETATION OF BOERSCH EFFECT. Ichinokawa, Takeo (Waseda Univ., Tokyo). Jap. J. Appl. Phys., 8: 137-44(Feb. 1969).

The energy broadening of an electron beam depended on the beam current, so called Boersch effect, was examined by an energy analyzer of a cylindrical magnetic type at a beam energy of 50 kV. The energy analysis was carried out by the caustic method. Even in an electron beam of 60 μA and a current density of 10^{-1} A/mm^2, the half width of the energy spread became 0.5 eV by decreasing the divergent angle of the incident beam. This value agrees with the half width deduced from the cathode temperature assuming the energy distribution Maxwellian. Moreover, the line shift S due to the variation of the incident angle α was measured by inclining the electron beam from the optical axis, and $dS/d\alpha$ was 1 volt/1 $\times$ 10^{-4} rad. Thus it is concluded that the energy broadening due to the beam current is to be regarded as an effect of the divergent angle of the incident beam. Characteristics of three cathodes, i.e., usual hair pin cathode of tungsten wire, pointed cathode, and oxide cathode are discussed from a view of line broadening. (auth)

14635 POLARIZATION OF LYMAN α RADIATION IN HYDROGEN–RARE GAS COLLISIONS. Dose, V. (Queen's Univ., Belfast). J. Phys., B(London), 2: 19-24(Jan. 1969).

The polarization of Lyman α radiation is calculated in the Born and distortion approximation, including rotational coupling between the hydrogen magnetic substrates. The rare gases helium, neon, and argon are represented by their Hartree–Fock potentials. Comparison with recent experiments shows that both rotational coupling and distortion must be considered to obtain reasonable agreement between theory and experiment. (auth) (UK)

14636 ELECTRON EXCITATION BY PROTONS IMPINGING ON HYDROGEN ATOMS IN A FIRST ORDER IMPACT PARAMETER TREATMENT. Van Den Bos, J.; De Heer, F. J. (FOM-Instituut voor Atoom- en Molecuulfysica, Amsterdam). Physica, 34: 333-48(1967).

A method utilizing Fourier techniques is outlined by which analytical expressions can be found for transition amplitudes and cross sections in a first-order impact-parameter formulation of the electron excitation induced by protons impinging on hydrogen. The method is applied to two kinds of processes, viz., direct excitation of the hydrogen atom and capture of an electron (into an excited state) by the incoming proton. Calculations are done for transitions from the initial state 1s to the final states 1s, 2s, $2p_z$, $2p_x$, 3s, $3p_z$, $3p_x$, $3d_z$, $3d_{xz}$, $3d_{xy}$ (elastic scattering excluded). Also expressions for the polarization of the p–s and d–p transitions are derived. (auth)

14637 ENERGY LOSS OF CHARGED PARTICLES IN MATTER. I. EXPERIMENTAL METHOD AND VELOCITY DEPENDENCE OF THE ENERGY LOSS OF LITHIUM IONS. Neuwirth, Wolfgang; Hauser, Ulrich; Kuehn, Ernst (Univ., Cologne). Z. Phys., 220: 241-64(1969).

A new method of determining the differential energy loss of charged-excited nuclei in matter is described. The method is based on the velocity dependence of the Doppler shift of the gamma quanta emitted by moving nuclei. No theoretical assumptions concerning the velocity dependence of atomic or nuclear collisions are necessary. The method and mathematical analysis, described in detail, are applied to the energy loss of Li ions emitting gamma quanta of 477 keV in the kinetic energy range between 100 and 800 keV. It is found that the energy loss of Li ions is linearly proportional to the velocity within 2% for several substances of Z = 1 to 74. The small limits of error that can be obtained, allow an application of this method to questions, e.g., the Z dependence of the stopping power on the nuclear charge of the stopping material, chemical binding effects, the time dependence of the adjustment of the equilibrium charge of the projectile after nuclear reactions, or the determination of nuclear angular correlations. (auth)

14638 A REVIEW OF ATOMIC AND MOLECULAR EXCITATION MECHANISMS IN NONEQUILIBRIUM GASES UP TO 20,000°K. Gilmore, F. R. (RAND Corp., Santa Monica, Calif.); Bauer, Ernest; McGowan, J. W. J. Quant. Spectrosc. Radiative Transfer, 9: 157-83(Feb. 1969).

A summary is given of present knowledge of the atomic and molecular mechanisms that produce or remove rotationally, vibrationally, and electronically excited species in heated or excited gases. A logical classification scheme for these mechanisms is introduced, and the extent of present information on each class is indicated. The validity and utility of several general rules and regularities are also examined. An appendix includes a table of rate coefficients for vibrational and electronic excitation and de-excitation reactions, taken directly from or derived from data in the literature. This table provides comprehensive coverage of some classes of reactions and representative coverage of others. (auth) (UK)

14639 AN ISOTOPE EFFECT ON $6^2P_{\frac{1}{2}}$–$6^2P_{\frac{3}{2}}$ MIXING IN CESIUM, INDUCED IN COLLISIONS WITH CH_4 AND CD_4. McGillis, D. A.; Krause, L. (Univ. of Windsor, Ont.). Can. J. Phys., 47: 473-4(Feb. 15, 1969).

$6^2P_{\frac{1}{2}} \rightleftharpoons 6^2P_{\frac{3}{2}}$ excitation transfer in cesium, induced in collisions with CH_4 and CD_4 molecules, has been studied in relation to the temperature of the vapor–gas mixtures. The variation with temperature of the cross section ratio $Q(CH_4)/Q(CD_4)$ is ascribed to an isotope effect which is interpreted on the basis of the theory of absolute reaction rates. (auth) (Canada)

14640 NON-VERTICAL TRANSITIONS IN THE COLLISION-INDUCED DISSOCIATION OF 0.7 TO 2 keV H_2^+ IONS. Moran, T. F.; Fullerton, D. C. (Georgia Inst. of Tech., Atlanta). Chem. Phys. Lett., 2: 625-8(Dec. 1968).

The momentum distribution of protons produced in dissociative H_2^+ reactions was measured for reactant ions in the 0 to 6th vibrational energy levels. The reaction mechanism inferred from this momentum distribution is consistent with the predominance of nonvertical transitions below 1.5 keV. (auth)

14641 DETERMINATION OF MUONIUM HYPERFINE STRUCTURE INTERVAL THROUGH MEASUREMENTS AT LOW MAGNETIC FIELDS. Thompson, P. A.; Amato, J. J.; Crane, P.; Hughes, V. W.; Mobley, R. M.; zu Putlitz, G.; Rothberg, J. E. (Yale Univ., New Haven, Conn.). Phys. Rev. Lett., 22: 163-7 (Feb. 3, 1969).

The ground-state hyperfine structure interval $\Delta\nu$ of muonium was remeasured with significantly improved accuracy through the observation of transitions between hfs states at low magnetic fields. The formation of muonium was observed for the first time in krypton, and the fractional pressure shift of $\Delta\nu$ has been measured in this gas. The average value of $\Delta\nu$ obtained from these measurements is $\Delta\nu$ = 4463.26 ± 0.04 Mc/sec. (auth)

14642 STEP-FUNCTION MODEL FOR CALCULATION OF TOTAL CROSS SECTIONS IN ATOMIC SCATTERING. Dohmann, H. D. (Univ., Bonn). Z. Phys., 220: 229-37(1969). (In German).

The usefulness of a step-function model as a molecular interaction potential for calculation of cross sections is demonstrated. Certain rules for the approximation of realistic potentials by the model are given. (auth)

14643 STOPPING POWERS AND RANGES OF ENERGETIC HEAVY IONS IN GAS STOPPING MEDIA. Pierce, Timothy Ellis. New York, Univ. of Rochester, 1968. 117p.

Thesis.

Stopping powers and partial ranges of energetic (5 to 100 MeV) beams of ^{32}S, ^{35}Cl, ^{79}Br, and ^{127}I ions in hydrogen, helium, nitrogen, argon, and krypton were measured. Beams were accelerated on the University of Rochester's M.P. tandem Van de Graaff accelerator. Using a gas cell with a mylar window, the energy of the degraded beam was measured with a previously calibrated silicon surface-barrier detector. $\Delta E/\Delta X$ data were extracted by taking the ratio of an energy increment and the corresponding gas thickness. $\Delta E/\Delta X$ values are accurate to an average of 3%. Partial ranges were calculated from the gas thicknesses and corresponding energy increments with graphical interpolation to convert energy loss measurements made with different initial beam energies. Accuracies of the partial ranges are better than 1%. The $\Delta E/\Delta X$ data were correlated using the stopping equation of Bethe. Heavy ion stopping powers were used in comparison with proton stopping powers to get an effective charge, Z_1, for the heavy ions. Comparison of the ratio of the calculated effec-

tive charge to the nuclear charge of the ions versus a reduced velocity parameter, based on the Thomas–Fermi electron velocity, gave a smooth curve for all heavy ions in all media with the exception of hydrogen. These curves give the ability to predict heavy ion stopping powers to within 6%. Effective charges measured in both gas and solid media fall on a single curve. The rms charge states measured for heavy ions show definitely higher charges after passage through solid media than through gaseous media. There is good agreement between the rms charge measured with gas strippers and the effective charges of the same ion in both solid and gaseous media. A possible explanation for the difference between effective and rms charges of heavy ions in solids is discussed in terms of differences in electron densities in solids and gases. (Disser. Abstr.)

14644 TWO-PHOTON IONIZATION OF THE HYDROGEN ATOM. Rapoport, L. P.; Zon, B. A.; Manakov, L. P. (Voronezh State Univ., USSR). Zh. Eksp. Teor. Fiz., 56: 400-1(Jan. 1969). (In Russian).

An analytical expression in terms of the Appel function F_1 was obtained for the cross section for two-photon ionization of the hydrogen atom. (auth)

14645 EXCITATION OF THE $\lambda = 4278$ Å BAND OF THE FIRST NEGATIVE SYSTEM OF THE N_2^+ ION BY NOBLE GAS IONS AND ATOMS. Polyakova, G. N.; Erko, V. F.; Gusev, V. A.; Zats, A. V.; Fogel, Ya. M. (Physical-Technical Inst., Kharkov). Zh. Eksp. Teor. Fiz., 56: 161-6(Jan. 1969). (In Russian).

The excitation functions of the $\lambda = 4278$ Å band of the first negative system of the N_2^+ ion are measured. Light was excited by 1- to 30-keV He, Ne, and Ar ion and atom collisions with nitrogen molecules. It is concluded that charge exchange plays the main role in excitation of the $\lambda = 4278$ Å band by ion impact. The cross sections for excitation of the $B^2\Sigma_u^+$ ($\nu = 0$) level of the N_2^+ ion is compared with the total cross sections for formation of the ion obtained by the mass-spectrometry technique. (auth)

14646 MEASUREMENT OF PRIMARY SPECIFIC IONIZATION IN NOBLE GASES. Davidenko, V. A.; Dolgoshein, B. A.; Somov, S. V. (Moscow Engineering-Physics Inst.). Zh. Eksp. Teor. Fiz., 56: 3-7(Jan. 1969). (In Russian).

Various methods of measuring the primary specific ionization produced by a charged particle in a gas are examined. It is pointed out that as a rule, results of primary ionization measurements in noble gases are too high. An analysis of the causes of the experimental data exceeding the calculated values indicates that the true primary ionization value is most closely approached when the measurements are performed in streamer chambers. The correctness of the conclusions are confirmed by measurements of primary ionization in helium. (auth)

14647 GROUP DYNAMICS OF THE HYDROGEN ATOM. Kleinert, Hagen (Univ. of Colorado, Boulder). pp 427-82 of High Energy Physics and Fundamental Particles. Barut, Asim O.; Brittin, Wesley E. (eds.). New York, Gordon and Breach, Science Publishers, 1968.

It is shown that the internal structure of the composite quantum mechanical system of the hydrogen atom can be described completely in terms of simple group operations in the representation space of the noncompact group O(4,2). In summary, the algebraic structure is described in such a way that it can be generalized to particle physics. (L.B.S.)

14648 POLARIZED POSITRON ANNIHILATION IN A (110) NICKEL CRYSTAL. Mihalisin, T. W.; Parks, R. D. (Univ. of Rochester, N. Y.). Solid State Commun., 7: 33-5(Jan. 1969).

In addition to presenting data on this subject, it is shown that at each angle two planes through the Fermi sea contribute to the counting rates for the (100) and (110) directions, while three contribute for the (111). (auth) (UK)

14649 POSITRON LIFETIMES IN SILICONE FLUIDS. Sen, P.; Patro, A. P. (Saha Inst. of Nuclear Physics, Calcutta). Nuovo Cim., 59B: 12-18(Jan. 11, 1969).

Measurements have been made to determine the long-lived component, τ_2, and its intensity, I_2, of positrons decaying in normal and degassed silicone fluids of different viscosity grades. The results show that the lifetime, τ_2, of the triplet positronium decreases as the length of the chain of the silicone fluids increases, though the change is quite small. No dependence of the intensity, I_2, of the triplet positronium on molecular structure has been observed. No effect of the dissolved oxygen on triplet-positronium intensity has been observed. The large variation in τ_2 obtained by Gray et al. for normal aliphatic hydrocarbons having different chain lengths can be interpreted as arising mostly from density changes. (auth)

Cosmic Radiation

Refer also to abstracts 14500–14502, 14538, 14565, 14575, 14585, 14959, 14964, and 15075.

14650 (INSJ–110) CALCULATION OF THE PRODUCTION RATE OF RADIOACTIVITY BY COSMIC RAYS AT SEA LEVEL. Takagi, Jinzaburo; Tanaka, Shigeo (Tokyo Univ. (Japan). Inst. for Nuclear Study). Dec. 2, 1968. 24p. Dep.

The production rate of radioactivity induced by cosmic-ray muons and neutrons at sea level was calculated. It is predicted that the production by muons is comparable to that by neutrons at sea level. The results are presented for the production of ^{32}P from S, ^{39}Cl from Ar, and ^{59}Fe from Co. The observed production rates are well accounted for by combined production by muons and neutrons. (auth)

14651 ASTROPHYSICS OF COSMIC RAYS. Ginzburg, V. L. Sci. Amer., 220: No. 2, 51-63(Feb. 1969).

The reasons are discussed for classing cosmic radiation as one of the main components of the Universe (along with stars, planets, gas, and dust, and electromagnetic radiation). Topics considered include chemical composition, energy spectrum, electrons and positrons, radiation from cosmic rays, cosmic-ray sources in the Milky Way, extragalactic cosmic rays, models of the origin, galactic model, acceleration, and time. (W.D.M.)

14652 A RADIO OBSERVATIONAL TEST FOR LOW-ENERGY COSMIC RAYS IN THE GALAXY. Greenberg, D. W. (Univ. of California, San Diego). Astrophys. J., 155: L51-5(Jan. 1969).

Low-energy cosmic rays partially ionize neutral galactic hydrogen, and, when recombination takes place, some of the radiation is emitted as radio-frequency lines. These radio recombination lines provide a sensitive test for the existence of the cosmic rays in the interstellar medium. Cold H I clouds are likely emitting regions. (auth)

14653 ISOTOPIC COMPOSITION OF THE COSMIC RADIATION. Meyer, J. P. (CEN, Saclay, France). Bull. Inform. Sci. Tech. (Paris), No. 131, 3-15(Nov. 1968). (In French).

The experimental methods which allow (or will allow) measurements of the isotopic composition of cosmic radiation are summarized. The existing results on the abundance ratios $d/^4He$, $^3He/^4He$, and $^{13}C/^{12}C$ in the galactic cosmic radiation are presented, together with an outline of the results which are likely to be reached in the future. The information provided by the ratios $d/^4He$ and $^3He/^4He$ on the sources, interstellar propagation and solar modulation, the ratio $^{13}C/^{12}C$ on the nature of the sources (their temperature), and the ratio $^9Be + {}^{10}Be/^7Be$ on the mean age of the cosmic radiation are analyzed. (auth)

14654 GAMMA RAYS AND HIGH-ENERGY ELECTRONS IN THE COSMIC RADIATION. Agrinier, B.; Leray, J. P.; Parlier, B. (CEN, Saclay, France). Bull. Inform. Sci. Tech. (Paris), No. 131, 35-50(Nov. 1968). (In French).

Gamma rays with energy above 50 MeV and high-energy electrons are related in cosmic radiation. The processes leading to γ-ray production in the interstellar medium and particularly those indicating high-energy electrons are reviewed. The present knowledge on the cosmic-ray electrons is reviewed also. Estimates of the possibilities to detect cosmic γ rays with some projected and existing γ-ray telescopes are given. (auth)

14655 ENERGY SPECTRA AND ABUNDANCES OF THE COSMIC-RAY NUCLEI HELIUM TO IRON FROM THE OGO-I SATELLITE EXPERIMENT. Comstock, G. M.; Fan, C. Y.; Simpson, J. A. (Univ. of Chicago). Astrophys. J., 155: 609-17(Feb. 1969).

The differential energy spectra of He, B, C, N, O, Ne, Mg, Si, and the Fe group obtained by the authors above 20 MeV nucleon^{-1} from an experiment on the OGO-I satellite were re-evaluated by using new detector calibrations and an additional block of data. The results reported now cover the time interval October 1964 to November 1965, which spans the period of minimum solar modulation in the 11-year solar-activity cycle. The shapes of the energy spectra are modified at low energy as a result of the new analysis. However, since the shapes of the spectra relative to one another remain essentially the same, the conclusions reached by the authors in their earlier publication remain unchanged. The relative abundances of the nuclei were re-evaluated. The abundances for several nuclei have now been determined for the two energy intervals 50 to 100 and 100 to 200 MeV nucleon^{-1}. In addition to the abundances previously reported by the authors for He to Fe, the abundances for Na, Al, and the nuclear-charge groups (P–K) and (Ca–Cr) were obtained at low energy for the first time. The

implications of these abundances for the origin of the low-energy radiation are discussed briefly. The new methods for analysis are described, and the linearity of solid-state-detector response over the nuclear-charge range Z = 1 to Z = 26 is established. (auth)

14656 PROPAGATION AND SOURCE CHARACTERISTICS DERIVED FROM THE LOW-ENERGY, MULTIPLY CHARGED, COSMIC-RAY NUCLEI. Comstock, G. M. (Univ. of Chicago). Astrophys. J., 155: 619-43(Feb. 1969).

Models for the origin and propagation of the cosmic-ray nuclei which assume a uniform particle population defined by a single set of propagation and source characteristics (including recently proposed steady-state models with a broad path-length distribution function) do not look attractive in terms of the nearby interstellar energy spectra derived from recent low-energy measurements made on the OGO-I satellite. Instead, the properties of these interstellar energy spectra strongly suggest the existence of two distinct particle populations or "components." These two components would result from different types of sources or modes of propagation. It is shown quantitatively that such two-component models satisfy the present experimental results down to the lowest observed energies over the wide nuclear charge range of helium to iron. The constraints placed by the data on two-component models are discussed with the aid of calculated interstellar energy spectra of the nuclear charge groups He, B, CNO ($6 \leq Z \leq 8$), LH ($10 \leq Z \leq 15$), and the Fe group ($25 \leq Z \leq 28$) derived for several different sets of source and propagation parameters. These calculated spectra are compared with the observed energy spectra of these charge groups corrected for solar modulation. Physical conditions which may give rise to two distinct particle populations are discussed briefly. The analysis is based on the revised and updated differential kinetic energy spectra measured on the OGO-I satellite and reported by Comstock, Fan, and Simpson. (auth)

14657 COSMIC-RAY DEUTERIUM AND ^{3}He OF SECONDARY ORIGIN AND THE RESIDUAL MODULATION OF COSMIC RAYS. Ramaty, Reuven (Goddard Space Flight Center, Greenbelt, Md.); Lingenfelter, Richard E. Astrophys. J., 155: 587-608(Feb. 1969).

Assuming that cosmic-ray deuterons and helium-3 nuclei are of secondary origin, it is shown that a unique determination of both the cosmic-ray path length and the residual interplanetary field modulation at solar minimum may be made from a comparison of the calculated and measured intensities of these two nuclei. This determination does not depend on any assumptions regarding either the source spectra or the unmodulated proton-to-alpha particle ratio of the primary cosmic rays. The production of deuterium and helium-3 by cosmic-ray interactions in the Galaxy is calculated by considering energy-dependent cross sections, interaction kinematics, and demodulated cosmic-ray spectra. The resulting flux at the Earth is obtained by taking into account leakage from the Galaxy, ionization losses, nuclear breakup, and modulation. From a comparison of these calculations with the measured deuterium and helium-3 intensities at the Earth, it is concluded that within the experimental uncertainties all the data can be understood in terms of an energy-independent, cosmic-ray path length of 4 ± 1 g cm^{-2} and a residual interplanetary field modulation at solar minimum which above 600 MV is of the form $\exp(-\eta/R\beta)$ with $\eta = 0.35 \pm 0.15$ BV, where R and β are rigidity and velocity, respectively. (auth)

14658 THE COMPTON–GETTING EFFECT. Gleeson, L. J. (Monash Univ., Clayton, Victoria); Axford, W. I. Contracts DA-31-124-ARO-D-257; NGR-05-009-081. Astrophys. Space Sci., 2: 431-7(Dec. 1968).

The differential current density and anisotropy seen by an observer moving relative to the frame of reference in which a flux of cosmic-ray particles or photons is isotropic, is derived, assuming that the observer's speed is small. The results are applied to examples relevant to the theory of cosmic-ray modulation and the expected anisotropies of photons originating outside the galaxy. (auth)

Direct Energy Conversion

Refer also to abstracts 14378 and 15669.

14659 (CEA-CONF-1090) SUMMARY OF STUDIES OF LIFE OF THERMIONIC CONVERTERS IN THE LABORATORY. Bliaux, J.; Clemot, M.; Durand, J. P.; Gayte, B. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). [1968]. 12p. (In French). (CONF-680508-8). Dep.

From 2nd International Conference on Thermionic Electrical Power Generation, Stresa, Italy.

During 1966 and 1967, 16 converters of different origin were tested in-pile. The characteristics of the converters before introduction into the reactor, the operational characteristics, and the life of the converters were determined. The lifetime of each converter, the cause of breakdown, and the total energy converted were tabulated for each converter. The first group of converters failed primarily because of Cs leaks around the metal/ceramic seal. The improvement of this seal increased the lifetime from several hundreds of hours to more than 3000 hours of operation. In the second series of converters only the emitters (Mo/Re, Mo/W) have shown a significant alteration after operation. (J.S.R.)

14660 (GA-8634) DIAGNOSTIC AND THERMOMETRY METHODS FOR IN-PILE THERMIONIC CONVERTER TESTING. Yates, M. K.; Holland, J. W. (Gulf General Atomic, Inc., San Diego, Calif.). Jan. 1, 1969. Contract AT(04-3)-167. 49p. Dep. CFSTI.

The instrumentation and test procedure which were used on each converter tested in the pool reactor, are described. The data analysis is described, and the methods used to calculate emitter temperature and diode input power are discussed. The calculation and interpretation of the relative power and relative efficiency are discussed. Finally, errors inherent in the data and analysis are considered. (D.L.C.)

14661 DETERMINATION OF THE PREDOMINANT IONIZATION AND LOSS MECHANISMS FOR THE LOW-VOLTAGE ARC MODE IN A NEON PLASMA DIODE. Salinger, S. N.; Rowe, J. E. (Univ. of Michigan, Ann Arbor). J. Appl. Phys., 39: 4299-4307 (Aug. 1968).

A reaction-rate analysis is used to determine the relative importance of the predominant ionization and loss mechanisms in a neon low-voltage arc. Experimental data are derived from various experiments to determine density, cross section, etc. It is found that the resonance and metastable state atoms are primarily generated in a region near the cathode which corresponds to the "cathode ball-of-fire" region of the low-voltage arc. The predominant ion-generation process is found to be a result of collisions between excited atoms which cause the formation of a molecular ion. Direct ionization of ground-state atoms is of secondary but nonnegligible, importance. Consideration of quasi-equilibrium multistage ionization shows that, unlike the cesium low-voltage arc, it is unimportant in the neon low-voltage arc. The escape of resonance radiation accounts for approximately one-fifth of the total power loss while ionization accounts for approximately one-eighth. Most of the remaining power loss appears as power dissipation at the anode. (auth)

14662 THERMOELECTRIC–THERMOMAGNETIC ENERGY CONVERTER STAGING. Kooi, C. F.; Horst, R. B.; Cuff, K. F. (Lockheed Research Lab., Palo Alto, Calif.). J. Appl. Phys., 39: 4257-63(Aug. 1968).

An exact theory of staging of heat engines or coolers is given for the case where the individual stage efficiencies or coefficients of performance are functions only of the fractional temperature difference $\Delta T/T$ between the hot and cold sides of the stage. In this case, it is exactly true that, for an extremum in efficiency or coefficient of performance, the fractional temperature differences of each stage are equal. For the constant ZT case of thermoelectric and thermomagnetic engines and coolers this extremum is a maximum. Z is the isothermal thermoelectric or the adiabatic thermomagnetic figure of merit and T is the absolute temperature. The cases α = constant, $\rho \propto T$ and κ = constant for the thermoelectric engine or cooler, and $\alpha \propto T^{-1}$, $\rho \propto T^{-1}$ and κ = constant for the thermomagnetic engine or cooler are considered. Here α, ρ, and κ are, respectively, the appropriate thermopowers, resistivities, and thermal conductivities. Exact expressions are given for the efficiency and coefficient of performance for a single stage and for an infinitely staged device and also for the shape of the infinitely staged device. These expressions are the same for these two examples of constant ZT thermoelectric and thermomagnetic devices, thus simplifying device design. (auth)

14663 PREOBRAZOVATELI SOLNECHNOI ENERGII NA POLUPROVODNIKAKH. (Conversion of Solar Energy by Semiconductors). Moscow, Izdatel'stvo Nauka, 1968. 223p.

The results of the experimental study of thermo- and photoelectric solar energy converters are reported in 24 articles. The results of the testing of solar installations with semiconductor generators for lifting ground water to arid regions are reported. The properties of semiconductor materials as well as questions on the commutation of thermoelements are examined. Methods for the solution of problems on the concentration of direct solar radiation in helix installations and thermal optimization of generator receptacles are studied. Calorimetric apparatus are proposed for

the testing of the focusing device of the installation with thermoelectric energy converters. The results of the testing of optical elements of semiconductor converters were described. A separate abstract was prepared for one article dealing with radiation effects on thermoelectric materials. (tr-auth)

For an abstracts of the individual paper see: 14871.

14664 OPTIMIZATION OF A LINEAR-INDUCTION MHD MACHINE, CONSIDERING THE LONGITUDINAL END EFFECT. Valdmanis, Ya. Ya. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser., No. 5, 120-6(1968). (In Russian).

By means of the variation method, the current load distribution for a linear-induction MHD machine at the maximum value of the efficiency rate was obtained. The dependences of the optimum values of the efficiency rate on the relative length of the machine are presented. Investigation was carried for pumping as well as for generator conditions of operation. (auth)

14665 INDUCTION ALTERNATING CURRENT MHD GENERATORS. Milewski, J. Pr. Inst. Masz. Przeply., No. 34, 87-99(1967).

Desirability of producing ac electricity in MHD generator motivated this and other studies [Weh, Cerini and Elliott, Schultz and Ulber, Carpetis in the Proceedings of Eighth Symposium on Engineering Aspects of Magnetohydrodynamics, Stanford University(Mar. 28–30, 1967)]. Common to all these papers is the conclusion that, for an induction system to be practicable, high electric conductivity at the level of that of liquid metal is needed. The need for an alternating magnetic flux also tends to suggest a rotating system as a simpler one. (App. Mech. Rev.)

Fluid Physics

Refer also to abstract 14694.

14666 (NP–17752) ANNUAL PROGRESS REPORT, 1968. (Toronto Univ. (Ontario). Inst. for Aerospace Studies). Oct. 1968. 250p. Dep. CFSTI.

Progress is reported on the following areas of research mechanics of rarefied gases; plasma dynamics; hypervelocity flows, implosions, and impact; space power generation, advanced propulsion, and earth resource satellites; aerodynamic noise, subsonic aerodynamics; aerospace flight dynamics; materials science and structures; rocket research; molecular beams and surface interactions; high-temperature gas dynamics and gas physics; laser excitation diagnostics; flight transportation; and industrial and architectural aerodynamics. (W.D.M.)

14667 THE PROPAGATION OF ALFVEN WAVES IN A VISCOUS FLUID OF FINITE ELECTRICAL CONDUCTIVITY. II. El Mohandis, M. G. S.; Fahmy, Baghdad; El Fattah, Azza Abd (Ain-Shams Univ., Cairo). Nuovo Cim., 59B: 1-11(Jan. 11, 1969).

In part I of a previous paper (Nuovo Cim. 54 B, 124 (1968)), the fluid motion and magnetohydrodynamic disturbances due to the sudden introduction of a magnetic dipole placed parallel to the exciting field in a viscous, incompressible fluid of finite electrical conductivity were discussed. In part II of the same paper, another problem was investigated with the axis of the magnetic dipole placed perpendicular to the exciting field. In the present work, the above two cases are discussed with the sudden introduction of an oscillating dipole instead of a magnetic one. (auth)

14668 TWO-DIMENSIONAL STATIONARY ION DENSITY AND ELECTRIC FIELD DISTRIBUTION IN LINEARIZED ELECTROGASDYNAMIC CHANNEL FLOW. Brunne, M.; Malaczynski, G. (Inst. of Fluid-Flow Machines, Danzig). Bull. Acad. Pol. Sci., Ser. Sci. Tech., 16: 355-61(1968).

The mathematical analysis of a linearized electrogasdynamic channel is presented from the viewpoint of electric field properties. A model of a nonlinear electric power generator with nonmonotonic axial distribution of voltage in open circuit is obtained. Two-dimensional flow of a binary gas in a cylindrical channel is considered. An incompressible medium is assumed with atomic fluid prevailing over ionic fluid. The field of the ionic gas causes no flow disturbances. A parabolic radial velocity profile and constant axial velocity of the atomic fluid are assumed. The analysis is confined to the case of a constant ionic gas source acting throughout the entire flow field. Considerations are concerned with a stationary state of dielectric, electrically isotropic media. The distribution of ion density in EGD generators must represent a function, monotonically decreasing along the channel length. Because of required conditions the axial distribution of the electric field becomes a function of both coordinates. For this reason, for practical purposes the mean value has to be used. Equations are derived by which the generator nonlinear internal resistance is determined. An appendix describes the distribution of charge density on the assumption that the current of diffusion in axial direction is negligibly small, as compared to the current of convection and conduction. (BBB)

14669 THE RADIAL PULSATION OF AN INFINITE CYLINDER WITH VARIABLE DENSITY IN FORCE-FREE MAGNETIC FIELD. Srivastava, K. M.; Kushwaha, R. S. (Univ. of Jodhpur, India). Proc. Natl. Inst. Sci. India, Part A, 34: 56-66(Jan. 1968).

The radial pulsations of an infinitely conducting infinite fluid cylinder with variable density under its own gravitation and in a force-free magnetic field have been discussed. A series solution for the displacement function ψ has been obtained for the fundamental mode for different values of the square of the ratio of the Alfven velocity to the sound velocity at the axis. The results have been compared to those of Chakraborty and Ramamoorthy (1960). Relative variation in magnetic field has also been calculated. (auth)

14670 STABILITY OF A COLLAPSING OR EXPLODING CYLINDRICAL SHELL OF CONDUCTING FLUID IN THE PRESENCE OF A MAGNETIC FIELD. Bhatnagar, P. L.; Bhat, P. K. (Indian Inst. of Science, Bangalore). Proc. Natl. Inst. Sci. India, Part A, 34: 115-31(May 1968).

A discussion is presented of the stability of a collapsing conducting cylindrical shell of incompressible ideally conducting fluid in the presence of a magnetic field assuming the shell to be of finite thickness. Before any disturbance is imposed on the system, it is assumed that the shell is moving radially at a uniform speed. The problem was set as an initial-value problem and the stability of the system against the axial disturbances considered. The analysis was concentrated only on the small wave numbers, and the amplitudes of the perturbations were consequently expanded in powers of the wave number. The solution was evaluated up to the first power of the wave number in both exploding and imploding cases. In the exploding case, it is found that there is overstability in which the frequency of the growing oscillations is proportional to the rate of collapse, the thickness of the shell, and the initial magnetic field. In the imploding case, there is again instability in which the perturbation increases logarithmically, the growth rate of the instability being proportional to the rate of the collapse and the thickness of the shell. Thus, the finite thickness of the shell, the rate of collapse, and the initial trapped field have a significant influence on the stability of the shell. (auth)

14671 COEFFICIENT OF FRICTION OF POROUS MEDIA IN LIQUID MAGNETODYNAMICS. Vives, Charles; Ben Daoud, Mohamed (Faculte des Sciences, Algiers). Compt. Rend., Ser. A and B, 267: 757-60(Nov. 13, 1968). (In French).

The flow of an electroconducting liquid across a porous medium in the presence of a transverse magnetic field was studied experimentally. The fundamental parameters were given. The curves show the variations of the coefficient of friction for some values of these parameters. (tr-auth)

14672 HEAT TRANSFER IN MAGNETOHYDRODYNAMIC CHANNEL FLOW. Eraslan, Arsev H. (Univ. of Tennessee Space Inst., Tullahoma); Eraslan, Necdet F. Phys. Fluids, 12: 120-8(Jan. 1969).

The general mathematical problem of magnetohydrodynamic thermal entrance regions is investigated for a parallel plate channel by including the Hall effect, axial heat conduction, Joule heating, and viscous dissipation. The associated eigenvalue problem is solved by the Galerkin method and the results are presented for the temperature development in a channel under uniform wall temperature conditions. It is concluded that the Hall current has considerable effect on the thermal problem and that the axial heat conduction cannot be neglected for low Peclet numbers. (auth)

14673 SUB-ALFVENIC DUCT FLOW WITH A NONUNIFORM MAGNETIC FIELD. Peyret, Roger (California Inst. of Tech., Pasadena). Phys. Fluids, 12: 129-36(Jan. 1969).

The flow of a conducting fluid in a duct in the presence of a magnetic field with a small nonuniformity of the following kind is considered: for $x < 0$, the field is uniform and parallel to the axis 0x of the duct; for $x > 0$, the field is nonuniform and the curvature of the magnetic lines is small, of order ϵ. A perturbation theory is presented for the case of small magnetic Reynolds number R_m and small Alfvén number A. In particular, the flow field is determined to order ϵ and to zero order in R_m, and the magnetic field to order ϵR_m. Downstream, all the perturbations decay algebraically. The upstream perturbations of the flow field initially

decay exponentially, with ultimate algebraic decay of the ϵR_m-order terms. For the induced magnetic field, the upstream decay is algebraic. (auth)

14674 HYDROMAGNETIC FORCED FLOW AGAINST A POROUS ROTATING DISK. Subba Raju, P. V. (Indian Inst. of Tech., Kharagpur). Proc. Indian Acad. Sci., Sect. A, 68: 195-208(Oct. 1968).

This paper deals with the steady forced flow of a viscous, incompressible and electrically conducting fluid against a porous rotating disk when a uniform magnetic field acts perpendicular to the disk surface. For small suction the equations of motion are integrated numerically by Kármán–Pohlhausen method, but for large suction a series solution in the inverse powers of the suction parameter is obtained. The effects of disk porosity and magnetic field on the various flow parameters are discussed in detail. (auth)

14675 CERTAIN PROBLEMS IN THE TURBULENT FLOW OF A CHARGED DIELECTRIC LIQUID OF ONE POLARITY. Mkhitaryan, A. M.; Tokarev, V. I.; Ushakov, V. V. (Kiev Inst. of Civil Aviation). Gidroaeromekhanika, No. 5, 3-16(1967). (In Russian).

The energetics of the turbulent electrohydrodynamic (EHD) flows are derived and qualitative differences in relation to normal flows are studied. Three-dimensional EHD equations for nonstationary flows are written in terms of averaged quantities and such quantities as the turbulent analog of the Poynting vector are computed. Detailed semi-empirical analysis of the turbulent flow of a charged liquid dielectric in a flat nonconducting channel is provided for the cases where electric field is vanishing and where it is finite. The general EHD problem is also recast using the analogy with the statistics of quantum mechanics. This approach is based on the practical consideration that the resolution of turbulent fields is determined by the measuring probes, so that a certain amount of overspecification of the problem is avoided. The flow profile of the EHD flow is computed to provide the example of the operator mathematics of the quantum mechanics. (ATD)

14676 MAGNETOHYDRODYNAMIC OSCILLATORY FLOW ALONG AN INFINITE PLANE POROUS WALL WITH VARIABLE SUCTION. Messiha, S. A. S. (Assiout Univ., Egypt). Atti Accad. Sci. Torino. I. Cl. Sci. Fis., Mat. Natur., 102: 953-67(1967-68).

The problem discussed here is the flow of a two-dimensional incompressible, electrically conducting fluid in the presence of an external magnetic field along an infinite, unmagnetized but conducting, plane porous wall. The suction velocity normal to the wall, as well as the external flow velocity varies periodically with time about a non-zero constant mean. It is assumed that the viscous Reynolds number is equal to the magnetic Reynolds number. Expressions for the velocity and magnetic fields in the boundary layer are obtained in a non-dimensional form. Also the skin friction and the induced current along the wall are obtained in terms of the suction parameter A and two magnetic parameters K and S. It is found that the amplitudes of skin friction and induced current fluctuations are increased with increasing the suction velocity fluctuations while the phase lead of the skin friction is decreased. The phase lag of the induced current is decreased for small values, and increased for large values of the frequency parameter ω. The amplitude of skin friction fluctuations increases for all values of ω and A as the magnetic parameter S increases, while for increasing the magnetic parameter K, it increases for all values of ω at small A, but for large A it decreases for small ω and then increases for large ω. For increasing S the amplitude of induced current fluctuations decreases for all ω and A, while it increases with increasing K. The phase lead of the skin friction fluctuations increases for small ω and decreases for large ω and all A as S or K increases. The phase lag of the induced current increases for all ω and A as S increases while it depends on A as K increases. (auth)

Geophysics (Upper Atmosphere)

Refer also to abstracts 14543 and 14800.

14677 (JPRS-47311) USSR ACHIEVEMENTS IN SPACE RESEARCH (FIRST DECADE IN SPACE, 1957–1967). Blagonravov, A. A. (ed.). Translation of Uspekhi SSSR v Issledovanii Kosmicheskogo Prostranstva. Pervoye Kosmicheskoye Desyatiletiye, 1957–1967, Nauka, Moscow, 1968. 617p. CFSTI.

An attempt is made to familiarize the reader with the key directions, basic stages, and the more important results of space research. Fields covered in the book include meteorological research, studies of the upper atmosphere, radiation belts, cosmic rays, magnetic fields of the Earth and other planets, shortwave solar radiation, interplanetary plasma, space biology and medicine, and study of the Moon and circumlunar space. The role played by optical observations of earth satellites for geodesy and geophysics is also described. (W.D.M.)

14678 LUNAR DAILY HARMONIC GEOMAGNETIC VARIATION AS INDICATED BY SPECTRAL ANALYSIS. Gupta, Jagdish C. (Univ. of California, Los Angeles); Chapman, Sydney. J. Atmos. Terrest. Phys., 31: 233-52(Feb. 1969).

Two series of hourly magnetic data, one from 54 observatories, were analyzed spectrally and also, in some cases, harmonically. The main series was for the sunspot maximum 1957–1959, the other for the preceding minimum, 1953–1955. In all, 210 annual sets of hourly values, chiefly for the horizontal component H, were used. Prominent peaks appear in the spectra for the harmonics S_n (with frequencies n cycles/day) of the solar daily variation S, for n up to 4, and in a few cases even up to 11. Lower peaks are shown for the components L_n of the lunar daily variation L, up to 4, caused by the dynamo action, in the ionosphere, of the main term M_2 in the lunar atmospheric tide; the term L_1 possibly includes a significant part caused by the next main lunar tidal term, O_1 (diurnal). Other peaks appear less prominently, and may be identifiable with the L harmonics corresponding to dynamo action of minor lunar tidal terms; the indications of these peaks should be checked by harmonic analysis of longer series of data. For some of the data sets the amplitudes inferred from the spectral analysis are compared with those derived by harmonic analysis. The latter are systematically smaller, but for the solar harmonics S_n the difference is slight. It is large, however, for the main lunar harmonics derived from high latitude data, which show much irregular disturbance. (auth)

14679 SOLUTION OF THE COUPLED ION AND NEUTRAL AIR EQUATIONS OF THE MID-LATITUDE IONOSPHERIC F2 LAYER. Bailey, G. J. (Sheffield Coll. of Tech., Eng.); Moffett, R. J.; Rishbeth, H. J. Atmos. Terrest. Phys., 31: 253-70(Feb. 1969).

The time-dependent momentum and continuity equations for the ions and the time-dependent momentum equation for the neutral air are solved simultaneously for midlatitude F2-region conditions. In both momentum equations the nonlinear acceleration terms are omitted. The pressure gradients in the neutral air are derived from Jacchia atmospheric models; also included in the neutral air momentum equation are ion drag, Coriolis and viscous forces. It is shown that, compared with the results of Geisler (1967), in whose calculations only the neutral air momentum equation was solved, the phases of the neutral air wind velocities are little affected by the feedback interaction between the ion and neutral air equations but the magnitudes of the velocities are different. When the peak electron concentration N_mF2 falls below 10^5 cm^{-3}, as it does at night, the wind velocities are determined by viscosity and Coriolis forces rather than by ion drag. The zonal wind is found to have a small prevailing eastward component, much less than the observational value given by King–Hele and Scott (1967). With the values of the parameters used in these calculations (appropriate to sunspot minimum conditions), the behavior of N_mF2 by day is not the same as that usually observed. Variations of the coefficient of viscosity, the ion loss coefficient, and the ion–neutral collision frequency give results that demonstrate the effects of feedback between the equations. At night, because the ionization is raised by an equatorward wind, N_mF2 may remain almost constant for several hours before dawn, though its value is less than is normally observed. (auth) (UK)

14680 SOME PECULIAR TROPOSPHERIC AND GROUND EFFECTS ON SOLAR NOISE RADIO MEASUREMENTS AT 7 GHz. Matsuura, O. T.; Kaufmann, P.; dos Santos, P. Marques; Fanto, P. (Mackenzie Univ., Sao Paulo, Brazil). J. Atmos. Terrest. Phys., 31: 271-80(Feb. 1969).

The incident of solar radio flux fluctuations in nearly 1000 hr of continuous observations at 7 GHz was studied statistically, and it is shown that some tropospheric phenomena can be analyzed by this method. Of the fluctuations 93% were coincident with the presence of C_L clouds whose borders seem to be the major factors responsible for reflecting a portion of the incoming rays, producing interference fringes at the observer's site. Absorption effects were also sometimes observed, and small effects in polarization were qualitatively characterized. Such events could be easily confused with the "fluctuation" type solar bursts, and the results emphasize the need of improved criteria for the analysis of very small solar events, that exist at microwave wavelengths. Further work was developed on steady troposphere attenuation at larger zenithal angles, and on ground contribution at solar onset times. (auth) (UK)

14681 IONOSPHERIC REFLECTION COEFFICIENTS OF THE ELF RADIO WAVES TAKING THE EXISTENCE OF THE ION INTO CONSIDERATION. Yamashita, Michiro (Nagoya Univ., Japan). J. Atmos. Terrest. Phys., 31: 281-8(Feb. 1969).

Assuming a two-layered ionospheric model, the reflection coefficients of elf radio waves were calculated. It was found that the effect of ions becomes important in the Schumann resonance frequency band as the ion collision frequency decreases. (auth) (UK)

14682 COMPARISON OF SCINTILLATION DEPTHS OF RADIO STAR AND SATELLITE SCINTILLATIONS. Allen, Richard S. (Air Force Cambridge Research Labs., Bedford, Mass.). J. Atmos. Terrest. Phys., 31: 289-97(Feb. 1969).

A statistical comparison of the depth of scintillation of the 54 MHz beacon of the satellite Transit 4A to the depth consistent with 63 and 113 MHz observations of the radio star Cassiopeia A indicated that (a) a thin screen of irregularities of height about 450 km and size somewhat greater than 1 km may represent weak scintillation during quiet geomagnetic periods, but that (b) for scintillation indices above about 20%, or during periods with local magnetic K-index above 2, the analysis should be based on a thick layer of irregularities. (auth) (UK)

14683 Dst FIELD IN THE EQUATORIAL ELECTROJET REGION. Raja Rao, K. S. (India Meteorological Office, Trivandrum). J. Atmos. Terrest. Phys., 31: 299-306(Feb. 1969).

Equatorial hourly Dst values (Dst-ej) were calculated for the year 1958, using the observed hourly values of horizontal intensity at seven equatorial electrojet stations. These Dst values are compared with the Dst values obtained by Sugiura (Dst-L) from the observed hourly values of the horizontal intensity at low latitude stations outside the equatorial electrojet, for the three quietest days in each month. The two sets of Dst values differ notably in their daily variations during the months May to August. This is ascribed to a difference, during these months, between the S_q daily variation in and outside the electrojet. It is shown that Dst-ej and Dst-L during the three greatest magnetic storms of 1958, varied nearly in parallel with each other and with a_p; but the initial storm phase affected Dst-ej more than Dst-L, and during the recovery phase a_p decayed more quickly than Dst. During two of these three storms there were times of no DP currents. The D curves for two stations differing in longitude by 210° differed in a way suggesting that the DR current was flowing partly through the ionosphere. (auth) (UK)

14684 RATE OF OCCURRENCE OF VHF RADIO-AURORA OVER AN ELEVEN-YEAR PERIOD. Forsyth, P. A. (Univ. of Western Ontario, London). J. Atmos. Terrest. Phys., 31: 313-18(Feb. 1969).

The rate of occurrence of radio-aurora as observed by a vhf bistatic radio system operating in eastern Canada over a period of eleven years is reported. The diurnal and seasonal characteristics, although somewhat different from those reported earlier, are not inconsistent with the earlier results when the different experimental conditions are taken into account. The threshold of detection of radio-aurora was set at a level which produced an occurrence of just over 2% when averaged over a whole sunspot cycle. The results emphasize the great variability of the auroral process and specifically the variability of radio-aurora. (auth) (UK)

14685 HEIGHT PROFILE IN THE Sq CURRENT IN THE MIDLATITUDE IONOSPHERE. Kamiyama, Hiroshi (Tohoku Univ., Sendai). Sci. Rep. Tohoku Univ., Fifth Ser., 18: No. 2, 77-83(1966). (In Japanese).

Under the assumption that the ionospheric Sq current flows only in the horizontal direction, the height distribution of the current intensity is calculated as a function of the direction of an electrostatic field for a location at 20° geomagnetic latitude. The results show that the height profile of the current is subtly dependent on the direction of an electric field, the maximum current being sometimes near the E-peak and sometimes in the region between 120 and 130 km. Remarks are made on the change in the magnetic field detectable by a rocket-borne magnetometer as it passes through the region where currents flow. (auth) (Geophys. Abstr.)

14686 ARTIFICIAL PLASMA CLOUDS IN SPACE. Haerendel, Gerhard; Luest, Reimar. Sci. Amer., 219: No. 5, 81-4; 89-92(Nov. 1968).

Experiments are reviewed in which clouds of barium atoms were released by rockets at high altitudes and ionized by solar radiation. The interactions of these clouds of plasma with the electric and magnetic fields around the Earth are discussed in detail. (W.D.M.)

14687 CONCERNING THE LONGITUDINAL ELECTRIC FIELD IN THE MAGNETOSPHERE WITH QUASI-MAXWELLIAN DISTRIBUTION OF CHARGED PARTICLES. Samokin, M. V. Kosm. Issled., 6: 604-10(July-Aug. 1968). (In Russian).

Distribution of the longitudinal electric field and the charged-particle densities in the one-dimensional symmetric magnetic mirror were determined, using the known difference of potential between the magnetic equator and a certain plane, where complete absorption of the charged particles occurs. It was assumed that the particles, the mirror points of which are located between the equator and the plane of absorption, have Maxwellian distribution according to velocity, are lacking such a distribution according to velocity, and are designated quasi-Maxwellian. A discussion is given on the mechanism of formation of the soft component in the external belt of trapped radiation, connected with low-energy charged-particle precipitation in the polar atmosphere under the action of longitudinal electric fields in combination with the azimuthal drift of particles in nonhomogeneous magnetic fields, given the directed movement of matter in the magnetosphere. (tr-auth)

14688 CERTAIN PECULIARITIES IN THE DISTRIBUTION OF CONCENTRATION OF PLASMA AND ALFVEN VELOCITY FIELDS IN THE MAGNETOSPHERE. Kopytenko, Yu. A.; Raspopov, O. M. Kosm. Issled., 6: 611-16(July-Aug. 1968). (In Russian).

The peculiarities are considered of the distribution of concentration of plasma and fields of Alfven-wave velocities in the magnetosphere upon the calculation of the deformation of the dipole magnetic field by the field of the ring current of the radiation belt. The presence of the ring current in the magnetosphere leads to a change of conditions of extension of MHD waves. In particular, there is obtained a passing effect of Alfven waves, circulated according to near the Alfven-wave force or circulated according to the far line of force; the same effect is possible upon the extension of whistling atmospherics. (tr-auth)

14689 CONCERNING THE NATURE OF STABLE SHORT-PERIOD Pc3 AND Pc4 OSCILLATIONS OF THE GEOMAGNETIC FIELD. Kopytenko, Yu. A.; Raspopov, O. M. Kosm. Issled., 6: 617-23(July-Aug. 1968). (In Russian).

The possibility is examined of explaning the mechanism of generation of Pc3 and Pc4 pulsations of the geomagnetic field by the resonance of MHD waves in power tubes, connected to the radiation-belt maximum. The possibility is considered of explaining the experimental data given with the proposed model. (tr-auth)

14690 METHODS USED FOR INVESTIGATING THE LOWER IONOSPHERE. Bencze, Pal (Geophysical Research Inst., Sopron, Hungary). Fiz. Szemle, 18: 372-6(Dec. 1968). (In Hungarian).

The lower ionosphere, which ranges from 60 to 160 km, is an ionized medium; its most important characteristic is the density of the positive and negative ions. The chemical reactions which take place in this region are greatly affected by the temperature and the pressure, or density. The methods used for studying the lower ionosphere include "microscopic" ones, based on the determination of the photoionization, collision, and chemical ionization processes. The composition of the medium and its altitude-dependent changes may be determined by mass-spectroscopic measurement, using rockets. The so-called "macroscopic" methods are based on indirect measurements. They include determination of the strong absorption of electromagnetic waves emitted by broadcasting stations and special experimental senders. Natural electromagnetic waves, generated by lightning may be used to determine the conductivity of the medium in the lower ionosphere. The presence of inhomogeneities caused by high-charge-density spots in homogeneous ionized layers is of great importance for the measurements. (Review article, 17 references) (TTT)

14691 THE OVAL OF POLAR AURORAE AND RING CURRENT IN THE MAGNETOSPHERE. Shevnin, A. D.; Fel'dshtein, Ya. I.; Starkov, G. V. Kosm. Issled., 6: 598-603(July-Aug. 1968). (In Russian).

Using the estimates of Williams and Nessa, the position of the boundary of the closed lines of force on the night side of the Earth is calculated and represented graphically in relation to the field in the magnetospheric loop and the magnitudes of the ring current. Observations of the southern boundary of the oval of polar aurorae permitted a direct determination of the magnetic flow of ring current. On the day side, the same flow was calculated as a function of ring current parameters in the Akasofu–Cayley approximation. Comparison of the results of calculations leads to the conclusion that the ring current during magnetic storms extends to ~3 to 3.5 R_E. With the increase of the field of the ring current the thickness of the belt of protons grows at the expense of the removal of its external boundary and there occurs redistribution (increase) of pitch-angles. (tr-auth)

14692 OBSERVATION OF THE $O_2(^1\Delta_g - ^3\Sigma_g^-)0,1$ BAND IN THE DAY AIRGLOW. Gattinger, R. L. (National Research Council of Canada, Ottawa). Can. J. Phys., 47: 367-70(Feb. 15, 1969).

The $O_2(^1\Delta_g - ^3\Sigma_g^-)0,1$ band at a wavelength of 1.58 μ has been observed in the day airglow with a ground-based scanning grating spectrometer. The observations were made near local noon in March 1968, at 45.2° N, 75.5°W with the line of sight of the spectrometer directed towards the zenith. A spectrum with a resolution of 2 Å was obtained by employing signal averaging techniques. The brightness of the 0,1 band was approximately 630 kR. (auth)

14693 OMNIDIRECTIONAL ELECTRON INTENSITY CONTOURS IN THE EARTH'S OUTER RADIATION ZONE. Owens, Harry D. (Univ. of Iowa, Iowa City). Proc. Iowa Acad. Sci., 74: 196-203(1967).

Intensity contour maps of the outer radiation zone for omnidirectional intensities of electrons with energies greater than 40 keV, 230 keV, and 1.6 MeV are presented for the time period October 1962 through January 1963. The manipulations applied to the Explorer 14 data are discussed along with the salient features and advantages of this presentation. (auth)

14694 MAGNETOHYDRODYNAMICS OF THE EARTH'S MAGNETIC FIELD. Venezian, G. Int. Shipbuil. Progr., 14: 120-6 (Mar. 1967).

A survey of observational and theoretical work pertaining to the origin of planetary magnetic fields is given with special emphasis on the dynamo theory which attempts to explain these fields as arising from magnetohydrodynamic regenerative action. Some points are raised regarding what a satisfactory theory should contain. It is suggested that reversals may occur without a drastic change in the internal flow. A method of using one model of dynamo action to obtain information about the structure of the flow in the core of the Earth is proposed. (auth) (App. Mech. Rev.)

Low-Temperature Physics

Refer also to abstracts 14038 and 15224.

14695 (N-68-35356) ULTRASONIC ATTENUATION IN SUPERCONDUCTING TANTALUM. Sarafi, Zoltan W. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Sept. 1968. 23p. (NASA-TN-D-2806). CFSTI.

Ultrasonic attenuation was measured in single crystals of tantalum at frequencies from 30 to 330 MHz. The crystals were oriented in the (100) and (110) directions. The attenuations of longitudinal and transverse waves were measured as a function of temperature and magnetic field. Curves are presented showing the transition between the normal and superconducting states. The zero-temperature energy gaps obtained were 3.3 kT_c for both directions. The samples had g/values intermediate between those used by other investigators, and a comparison of results indicated that the energy gap in tantalum is lower for samples with larger electronic mean-free paths. (auth) (STAR)

14696 (ORNL-TM-2441) MAGNETIC FLUX FLOW AND SUPERCONDUCTOR STABILIZATION. Quarterly Report Covering the Period from July 1, 1968-September 30, 1968. Gauster, W. F.; Efferson, K. R.; Kroeger, D. M.; Lubell, M. S.; Simpkins, J. E. (Oak Ridge National Lab., Tenn.). Nov. 1968. Contract W-7405-eng-26. 99p. Dep. CFSTI.

This quarterly report consists primarily of three papers that have been presented at conferences and will soon appear in the open literature. Appendix I, "Flux Flow Studies and Stability Criteria of NbTi Stripe" by Lubell and Kroeger, will appear in Cryogenic Engineering Vol. 14, 1969. Appendices II and III, "Steady State Performance of Multistrand Superconducting Compound Conductors," by Gauster and "Heat Transfer from Cylindrical Surfaces to Liquid Helium I" by Efferson, will appear in the April issue of The Journal of Applied Physics. (M.H.R.)

14697 LOW-TEMPERATURE HEAT CAPACITIES OF α-MANGANESE, CESIUM, AND RUBIDIUM. Martin, Byron Dale. Columbus, Ohio, Ohio State Univ., 1968. 89p.

Thesis.

A cryostat capable of obtaining temperatures as low as 0.05°K has been designed, constructed, and operated successfully. It has been used to measure the heat capacities of α-manganese, cesium, rubidium, and copper down to 0.2°K. An evacuable stainless steel cylinder, sealed with an indium O ring, encloses the ^{3}He copper block, the sample, and a paramagnetic salt pill. The sample and salt are suspended from the ^{3}He copper block by frames. Lead thermal valves connect the salt to the ^{3}He block, and the sample to the salt. Superconducting solenoids operate these links. A large superconducting solenoid is used for adiabatic demagnetization cooling of the paramagnetic salt. The results of the low-temperature heat capacity measurements on Cs from 0.15 to 0.5°K give 1.53 for the thermal effective mass ratio m^*/m_e, and 41.7°K for θ_D. For Rb, measurements were obtained from 0.2 to 0.4°K, but the results agree well with earlier measurements on the same sample from 0.4 to 2°K, which gave $m^*/m_e = 2.14$ and $\theta_D = 58.7$°K. For Cu, measured from 0.2 to 0.8°K, the results are well within the range of values obtained by others for copper. Most importantly, the copper measurements give a straight line plot of C/T versus T^2, demonstrating the validity of the carbon resistor calibration. The α-Mn sample, measured from 0.18 to 0.4°K, clearly exhibits a $1/T^2$ dependent term in the heat capacity. This hyperfine interaction term suggests an effective magnetic field of the electrons at the Mn nucleus of 74 kilogauss. Nuclear magnetic resonance experiments suggest a lower field. Neutron diffraction data indicate four crystallographically independent sites in a 58 atom Mn unit cell. (TSS)(Diss. Abstr.)

14698 FLUX MOBILITY PROPERTIES ASSOCIATED WITH DIAMAGNETISM IN HYSTERETIC TYPE II SUPERCONDUCTORS. Schweitzer, D. G.; McInturff, A. D. (Brookhaven National Lab., Upton, N. Y.). Solid State Commun., 6: 885-7(Dec. 1968).

Through appropriate cycles using both senses of the applied magnetic field, magnetic energy can be stored in Type II superconductors that do not exhibit appreciable diamagnetism. An isothermal field cycle was performed so that the total magnetic moment was zero when H = 0. Upon heating in H = 0, the sample developed a magnetic moment which increased with temperature, passing through a maximum and decreasing to zero at the critical temperature. Diamagnetic superconductors do not exhibit this phenomenon. The effect implies a mobility of internal field lines that is associated with diamagnetic behavior. The technique demonstrates preferential thermal stability of the field initially retained in superconductors exhibiting minimal diamagnetic behavior. (auth)(UK)

14699 THE THERMAL CONDUCTIVITY OF SILICON DIOXIDE GLASS FROM 0.5 TO 4.2K. Fisher, R. A.; Brodale, G. E.; Hornung, E. W.; Giauque, W. F. (Univ. of California, Berkeley). Rev. Sci. Instrum., 40: 365-6(Feb. 1969).

The thermal conductivity of silicon dioxide glass at 0.5 to 4.2°K was studied during a continuing search for materials suitable for the construction of apparatus for magnetothermodynamic measurements at low temperatures and for use in high magnetic fields. (B.G.D.)

14700 STABILITY OF A CURRENT RING SUPPORTED IN A MAGNETIC FIELD. Neil, V. Kelvin (Univ. of California, Livermore); Cooper, Richard K. Rev. Sci. Instrum., 40: 295-304 (Feb. 1969).

The stability of a superconducting, current-carrying ring levitated in a static magnetic field is investigated theoretically. The azimuthally symmetric supporting field has components B_r, B_θ, and B_z. A first-order perturbation calculation is performed to determine the oscillation frequencies of the stable modes and the stability criteria for the potentially unstable modes. In the absence of external feedback and/or image currents in the surrounding walls, the ring is unstable. The stability criteria involve the ring current and mass as well as the configuration of the external field and the surrounding walls. It is found that the ring may be stabilized by proper choice of the wall configuration, and if a given configuration is not such as to satisfy the stability criteria, the magnitude of external feedback necessary may be determined from the results. (auth)

14701 INFLUENCE OF ALPHA-IRRADIATION ON THE TRANSITION TEMPERATURE OF SUPERCONDUCTIVE TIN, INDIUM, AND THALLIUM FOILS. Van Itterbeek, A.; Van Poucke, L.; Bruynseraede, Y.; David, J. (Instituut voor Lage Temperaturen en Technische Fysica, Louvain, Belgium). Physica, 34: 361-4(1967).

Tin, thallium, and indium foils were α-irradiated at 4.2°K. It was found that the decrease of the transition temperature is in agreement with those obtained for alloyed or plastically deformed samples. (auth)

14702 FERROMAGNETIC INCLUSIONS IN TYPE-II SUPERCONDUCTORS. Brochier, D.; Cardinne, P.; Renard, M. J. Phys. (Paris), 29: 953-6(Oct. 1968). (In French).

In type-II superconductors a strong interaction between vortex lines and small ferromagnetic particles may be expected. Results have been obtained with PbHg alloys; Fe particles have been introduced by electrolysis of ferrous salts on a mercury cathode. The magnetic origin of the observed irreversibility is pointed out and

also the influence of concentration and size of the Fe particles. (auth)

14703 ON THE EXISTENCE OF A CORRUGATED SURFACE REPRESENTING THE RELATIONSHIP BETWEEN CURRENT, VOLTAGE, AND MAGNETIC FIELD FOR WEAKLY-CONNECTED SUPERCONDUCTORS. Omar, M. H.; Kraan, W. H.; De Waele, A. Th. A. M.; De Bruyn Ouboter, R. (Kamerlingh Onnes Laboratorium, Leiden). Physica, 34: 525-33(1967).

The research on the behavior of various types of double-contact junctions between weakly connected superconductors has been extended by developing junctions with better defined area between the weak contacts. Both voltage and critical current oscillations have been measured. Furthermore, special attention has been paid to double contact junctions with relatively small self-inductances in order to obtain larger amplitudes for both critical current and voltage oscillations. For such junctions a three-dimensional diagram is constructed showing a corrugated surface for the relationship between current, voltage, and magnetic field. The temperature dependence of the critical current oscillations is measured for Sn/Nb junctions. (auth)

14704 THE RELATIONSHIP BETWEEN CURRENT, VOLTAGE, AND MAGNETIC FIELD FOR A SUPERCONDUCTING DOUBLE-POINT-CONTACT DIODE PLACED IN THE CENTER OF A COAXIAL CAVITY. De Bruyn Ouboter, R.; Kraan, W. H.; De Waele, A. Th. A. M.; Omar, M. H. (Kamerlingh Onnes Laboratorium, Leiden). Physica, 35: 335-40(1967).

The research on the relationship between current, voltage and magnetic field for a superconducting double-point-contact diode has been extended by investigating its behavior in its own resonant electromagnetic radiation field, when the diode is placed in the center of a coaxial cavity. When the product of the external magnetic field strength and the area between the double contacts is equal to a whole number of magnetic flux quanta (and hence the circulating current is equal to zero) the current–voltage curve shows pronounced constant voltage steps at voltages corresponding to a resonance frequency of the coaxial cavity. These voltage steps disappear completely when the product of the external magnetic field and the enclosed area is equal to a half number of flux quanta, corresponding with a maximum circulating current. The voltage steps can also be seen in the V–H oscillations. Three similar coaxial cavities have been investigated. The first and second voltage steps of each cavity are in a reciprocal ratio to the dimensions of the cavity. (auth)

14705 FORMALISM OF LAMBDA PHASE TRANSITIONS. Gorter, C. J. (Kamerlingh Onnes Laboratorium, Leiden). Physica, 34: 220-2(1967).

There are logarithmic lambda phase transitions of different character. It is suggested that the order of a transition according to the two-dimensional Ising model and of that between the superconductive and the superconductive mixed state be called $2-\kappa$ and $1+2\kappa$ respectively. The quantities describing such lambda transitions are the magnitude A, the width θ and h, which is the coefficient of κ. (auth)

14706 EXCITATION SPECTRUM FOR A BOSE GAS WITH REPULSIVE CORE AND ATTRACTIVE WELL. Brown, Gerald V. (Lewis Research Center, Cleveland); Coopersmith, Michael H. Phys. Rev., 178: 327-44(Feb. 5, 1969).

The correct qualitative features of the helium II elementary excitation spectrum are derived microscopically for a realistic interparticle potential using a form of pair Hamiltonian. The strong repulsive core is included by using reaction matrix elements in the Hamiltonian, and the attractive well is successfully included by assuming a generalized Bose–Einstein condensation. The pair Hamiltonian is diagonalized by the thermodynamically equivalent Hamiltonian method of Wentzel. Numerical solution of the equations yields spectra with phonon and roton regions. Since the energies in the spectrum are too high when the Yntema–Schneider potential is used, another potential is constructed which still fits the second-virial-coefficient data and gives better results. Spectra calculated for a series of attractive well strengths show the effect of weaker wells. (auth)

14707 CRITICAL VELOCITY OF A SUPERFLOWING LIQUID-HELIUM FILM USING THIRD SOUND. Pickar, K. A.; Atkins, K. R. (Univ. of Pennsylvania, Philadelphia). Phys. Rev., 178: 389-99 (Feb. 5, 1969).

An investigation of the critical velocity of the helium film is made by impressing a third-sound wave (surface ripple with van der Waals restoring force) on a superflowing film. The velocities of the wave are measured traveling upstream and downstream, and the superfluid critical velocity is deduced as $V_c = \frac{1}{2}(U_{3down} - U_{3up})$. The critical velocity at the lowest temperature (1.25°K) as a function of the film height is found to be close to $\hbar/2md$, where d is the film thickness. This is compared with existing theories and is found compatible with the velocity necessary for the stability of a vortex-line-image pair with a separation of 2d. Disturbing effects produced by the method used to excite the third sound make it impossible to measure the critical velocity at high temperatures. Arguments are advanced for believing that these disturbing effects do not invalidate the low-temperature results. Since the third-sound wave is formed by the longitudinal oscillation of the superfluid component, the observation of the wave in a film which is flowing at the critical velocity indicates the possibility of film velocities in excess of V_c for measured times $T \sim 10$ msec, where T is half a third-sound period. This implies that there is no relaxation time τ for the creation of vortices where $\tau > T$. From the data, an upper limit is placed on the difference in thickness between the flowing film and a static film. (auth)

14708 TEMPERATURE-DEPENDENT INTERACTION AND THERMODYNAMIC PROPERTIES IN SUPERCONDUCTORS. Rothwarf, A. (RCA Labs., Princeton, N. J.). Phys. Lett., 28A: 430-1(Dec. 30, 1968).

The temperature dependence of the interaction in superconductors is used to calculate the relation between $\Delta(0)/kT_c$ and $(dh/dt)_{t=1}$ as well as the specific heat jump at T_c. (auth)

14709 TEMPERATURE AND ORIENTATION-DEPENDENT SURFACE CRITICAL CURRENT IN SUPERCONDUCTING NIOBIUM SINGLE CRYSTALS. Williams, I. (National Physical Lab., Middlesex, Eng.). Phys. Lett., 28A: 409-10(Dec. 30, 1968).

A pronounced anisotropy is observed in the surface critical current of Nb single crystals at low temperature. It is believed to be related to the anisotropy in κ. (auth)

14710 ULTRASONIC ABSORPTION IN INTERMEDIATE-PURITY TYPE-II SUPERCONDUCTORS. Tittmann, B. R.; Boemmel, H. E. (North American Rockwell Corp., Thousand Oaks, Calif.). Phys. Lett., 28A: 396-7(Dec. 30, 1968).

Ultrasonic absorption measurements on reversible V–5 at. % Ta with $\kappa \approx 7$ and $\xi_0/l \approx 5$ provide sensitive characterization of the regime of type-II behavior intermediate between the very pure and very dirty limits. (auth)

14711 SUPERCONDUCTING QUANTUM ELECTRONICS. Silver, Arnold H. (Ford Motor Co., Dearborn, Mich.). IEEE (Inst. Elec. Electron. Eng.), J. Quant. Electron., QE-4: 738-44 (Nov. 1968).

The quantum electronic properties of superconductors have been vividly demonstrated by means of experiments on Josephson tunneling junctions and small area superconducting contacts. Emphasis is placed on ring configurations where quantum-state transitions corresponding to changes of magnetic flux of 2.07×10^{-15} webers are directly observed. Such systems can be used to make ultrasensitive measurements of magnetic fields, electric currents and voltages, cryogenic temperatures, and electromagnetic radiation. (auth)

14712 TRANSITION OF A HOMOGENEOUS TYPE-II SUPERCONDUCTOR CYLINDER UNDER THE INFLUENCE OF AXIAL CURRENT. Hlasnik, I.; Takacs, S. (Electrotechnical Inst., Bratislava). Czech. J. Phys., 19: 59-71(1969).

The magnetic field distribution and the resistance of a homogeneous type II superconductor cylinder at transition under the influence of axial current in zero external magnetic field were calculated. In this calculation, the magnetic field dependence on flow resistivity ρ_f was expressed by two or more potential functions, and it is shown that the accuracy of this approximation is sufficient. For some values of the lower critical field and various temperatures, the magnetic field distribution and the resistance of the cylinder are calculated as a function of the applied electrical field and/or the applied current. The temperature dependence of the electric field at which the normal state appears on the surface of the cylinder is also given. (auth)

14713 SPIN DIFFUSION IN TYPE-II SUPERCONDUCTORS. Asayama, Kunisuke (Osaka Univ.); Masuda, Yoshika. J. Phys. Soc. Jap., 26: 206(Jan. 1969).

The results of Goldberg and Weger (J. Phys. Soc. Japan, 24: 1279(1968)) on the spin–lattice relaxation time of Nb–Zr alloys contradict earlier results (ibid., 20: 1290(1965)). In order to determine whether the difference is due to spin diffusion, Nb–Zr alloys were prepared by the hydride-dehydride method and the longest time constant T_1 of nuclear magnetization measured and compared with that of filed samples. It is concluded that the spin diffusion effect exists in the mixed state and depends strongly on the microscopic inhomogeneous broadening. The time constant T_2 was also measured. (D.L.C.)

14714 IRREVERSIBLE BEHAVIOUR OF SUPERCONDUCTING NIOBIUM WIRES. Goedemoed, S. H.; Kes, P. H.; Jacobs, F. Th. A.; De Klerk, D. (Kamerlingh Onnes Laboratorium, Leiden). Physica, 35: 273-89(1967).

The magnetic moment of an impure niobium sample was measured simultaneously with the heat development during variation of an external magnetic field along the axis. This was done at several temperatures. The results were interpreted by means of a tentative relation in which the pinning force is assumed to be proportional to $(H_c - B)$, the coefficient being proportional to $(1 - t^4)$. The heat development and the enthalpy, which are derived from the experiment, can be described using the same relation and an additional assumption about "local reversibility." The flux jump region, which is observed below 3.5°K, is discussed in terms of the occurrence of a critical current or force density. No satisfactory interpretation of the formulae could be proposed on the basis of a model for the mixed state. (auth)

14715 SUPERCONDUCTOR QUATERNARY ALLOYS WITH HIGH CURRENT CAPACITIES AND HIGH CRITICAL FIELD VALUES. De Sorbo, Warren (to General Electric Co.). U. S. Patent 3,416,917. Dec. 17, 1968. Filed Apr. 18, 1966.

Rules for producing alloys with desirable superconducting properties include: (1) solute atoms should be larger than the base metal atoms; (2) the valences of parent and solute atoms should differ by at least two; (3) the density of extended defects should be large; and (4) the linear coefficient of the electronic specific heat should be as high as possible. Alloys which follow these rules comprise intermetallic compounds of Sn, Al, Si, or Ga with a solid-solution alloy of Nb, Ta, Ti, or V and a minor proportion of at least two metals from the group of Zr, Mo, U, and Re. Specific examples of such alloys are given. (D.L.C.)

14716 THEORY OF DILUTE SOLUTIONS OF ^{3}He IN LIQUID ^{4}He. Woo, Chia-wei (Northwestern Univ., Evanston, Ill. Univ. of California, San Diego, La Jolla); Tan, Hing-tat; Massey, Walter E. Phys. Rev. Lett., 22: 278-82(Feb. 17, 1969).

A microscopic calculation of the effective mass and interactions of ^{3}He quasi particles in dilute ^{3}He–^{4}He solutions is presented. The theory is first principles in the sense that it requires no other information than the bare masses of the helium atoms and a realistic two-particle potential. Findings in the limiting case of zero concentration are presented. (auth)

14717 HYDRODYNAMIC MODES IN ^{3}He–^{4}He MIXTURES AT THE CRITICAL POINT. Griffin, Allan (Univ. of Toronto). Can. J. Phys., 47: 429-34(Feb. 15, 1969).

At the critical mixing point of ^{3}He–^{4}He mixtures, the amplitudes of both the nonpropagating diffusion mode and second sound may become anomalously large. The damping of these two critical modes is discussed on the basis of Khalatnikov's two-fluid hydrodynamics. (auth)

14718 DAMPING OF VORTEX OSCILLATIONS IN SUPERCONDUCTORS OF THE SECOND KIND. Finkel'shtein, A. M. (Inst. of Theoretical Physics, Moscow). Zh. Eksp. Teor. Fiz., 56: 333-9(Jan. 1969). (In Russian).

The motion of vortexes in type-II superconductors is studied on the basis of hydrodynamic theory. Energy dissipation during vortex oscillations and damping due to nonlinearity of the equations describing the variation of the vortex shape are estimated. (auth)

14719 NUCLEATION OF SUPERCONDUCTIVITY IN TANTALUM IN A DECREASING MAGNETIC FIELD. McEvoy, J. P.; Jones, D. P.; Park, J. G. (Imperial Coll. of Science and Tech., London). Phys. Rev. Lett., 22: 229-31(Feb. 10, 1969).

Measurements of the surface nucleation field H_{c3} and the bulk supercooling field H_{sc}, made on pure tantalum, show that these fields are identical only when $\kappa < 0.39$, and that measurable supercooling occurs at all temperatures between T_c and 1.4°K. The measurements verify qualitatively the recent theoretical work of Park. Nearly ideal supercooling of the bulk cylindrical samples is achieved by using small auxiliary-field coils to field coils to eliminate nucleation at the sample ends. A new value for the Ginzburg–Landau parameter of the pure metal $\kappa_0 = 0.340 \pm 0.01$ is derived from the data. (auth)

14720 SPECIFIC HEAT AND THE LATTICE TRANSFORMATION IN Nb_3Sn. Vieland, L. J.; Wicklund, A. W. (Radio Corp. of America, Princeton, N. J.). Solid State Commun., 7: 37-9 (Jan. 1969).

The specific heat anomaly associated with the tetragonal–cubic lattice transformation in Nb_3Sn was measured. Specific heat, x-ray, and velocity of sound measurements on single crystal Nb_3Sn cannot be reconciled within the framework of current theories of the transformation. (auth) (UK)

14721 ON THE ELECTRODYNAMICS OF THE TYPE II SUPERCONDUCTORS. Khan, M. H. (Atomic Energy Research Establishment, Harwell, Eng.). Phys. Kondens. Mater., 8: 209-15(1968).

Using the two fluid model, modified Londons equations have been obtained for the type II superconductors in the Shubnikov state ($H_{c1} < H < H_{c2}$). The effect of the normal electrons which form the cores of the flux vortices has been included. These equations can be reduced to the Londons equations under suitable assumptions. The electric field inside the superconductor and the field equations have also been obtained. (auth)

14722 ULTRASONIC ATTENUATION IN NORMAL AND SUPERCONDUCTING INDIUM. Bliss, E. S.; Rayne, J. A. (Carnegie–Mellon Univ., Pittsburgh). Phys. Rev., 177: 673-87(Jan. 10, 1969).

Measurements of the electronic contribution to the attenuation of longitudinal sound waves propagating in normal and superconducting indium have been made up to 330 MHz. Data have been obtained for propagation along the principal crystallographic axes as well as for a number of directions in the (010) plane. The results exhibit considerable deviation from free-electron behavior. The limiting slopes of the attenuation versus frequency are highly anisotropic, and for quasi-longitudinal modes include a significant contribution which vanishes within approximately 30 mdeg of T_c. This drop is in addition to the less sudden drop associated with the BCS attenuation for longitudinal waves. Comparison of the measurements with simple calculations based on a modified free-electron model suggests that the effect of the crystal potential on the Fermi-surface topology is largely responsible for the observed attenuation behavior. (auth)

14723 ULTRASONIC ATTENUATION OF SHEAR WAVES IN SUPERCONDUCTING LEAD. Deaton, B. C. (General Dynamics, Fort Worth, Tex.). Phys. Rev., 177: 688-93(Jan. 10, 1969).

Ultrasonic attenuation measurements have been made for shear waves propagating along the [001] and [110] directions in high-purity single crystals of lead at frequencies 10–50 Mc/sec and temperatures 2–15°K. It was found that the temperature-dependent dislocation attenuation is only a small fraction of the total electronic attenuation of shear waves at the transducer voltages used, and therefore reliable data on the attenuation in the superconducting state can be obtained. The rapid-fall electromagnetic attenuation just below the transition temperature was analyzed on the basis of Fossheim's model, and bulk values of the London penetration depth were obtained for the two directions of propagation. The results are in reasonable agreement with thin-film data. The residual attenuation remaining at temperatures below the rapid-fall region was analyzed on the basis of the BCS equation, using the zero-temperature energy gap $2\Delta(0)$ as an adjustable parameter. The apparent energy gap $2\Delta(0)$ is frequency-dependent for $q \| [110]$ and $\epsilon \| [1\bar{1}0]$, varying from 4.4 kT_c at 10 Mc/sec to 3.4kT_c at 50 Mc/sec. For $q \| [110]$ and $\epsilon \| [001]$, for $q \| [001]$ and $\epsilon \| [110]$, and for $q \| [001]$ and $\epsilon \| [010]$, the data indicate essentially frequency-independent energy gaps of 3.1kT_c, 3.4kT_c, and 3.4kT_c, respectively. In addition to the above calculations of $2\Delta(0)$ using the ordinary technique of fitting the low-temperature portion of the data with the exponential in the BCS equation, the data were also fitted over the entire temperature range with BCS curves, using $2\Delta(0)$ to adjust the fit. The resulting values of $2\Delta(0)$ were somewhat larger than those given above, with the relative values remaining about the same. The range of gap values observed is in good agreement with the recent tunneling data of Rochlin. (auth)

14724 PROPERTIES OF SUPERCONDUCTING LEAD–INDIUM ALLOYS AND THE GENERALIZED GINZBURG–LANDAU PARAMETER κ_2. Farrell, D. E. (Case Western Reserve Univ., Cleveland); Chandrasekhar, B. S.; Culbert, Harvey V. Phys. Rev., 177: 694-703(Jan. 10, 1969).

Magnetization measurements have been made on a series of lead–indium alloys containing from 5 to 60 at. % indium. The upper and lower critical fields together with the generalized Ginzburg–Landau parameter κ_2 have been obtained at temperatures between $0.2T_c$ and T_c. Residual resistivities and transition temperatures have also been measured. It is found that κ_2 increases with decreasing temperature, the magnitude of the increase being much higher than that expected from existing theory. However, the increase as a function of the Gor'kov impurity parameter ρ closely follows available data for niobium alloys. This result lends support to the view that, despite the present conflict between experiment and theory, an experimental parameter $\kappa_2(\rho,T)$ does exist which is independent of the detailed characteristics of the alloy system being investigated. Temperature-independent

characteristics of the lead–indium system are collected together, and some evidence is found for a modification of the electronic structure at an indium concentration of about 30 at. %. (auth)

14725 CARRIER-CONCENTRATION-DEPENDENT SUPERCONDUCTIVITY IN SnTe AND GeTe. Allen, Philip B.; Cohen, Marvin L. (Univ. of California, Berkeley). Phys. Rev., 177: 704-6(Jan. 10, 1969).

A theoretical calculation is given of the dependence of the superconducting transition temperature on carrier concentration for the many-valley semiconductors SnTe and GeTe. The model used includes an accurate description of all intravalley processes; however, intravalley interactions alone are inadequate to explain the superconductivity of these materials. This contradicts the results of a recent model calculation of Hulm et al., which involved only intravalley interactions. Intervalley phonon-induced interactions are found to be the dominant mechanism. Good agreement with the available data over the entire range of carrier concentration is found by adjusting a single parameter, the intervalley deformation potential. (auth)

14726 THEORY OF SUPERCONDUCTING SEMICONDUCTORS AND SEMIMETALS. Koonce, C. S. (National Bureau of Standards, Washington, D. C.); Cohen, Marvin L. Phys. Rev., 177: 707-19(Jan. 10, 1969).

A Green's-function method is used to derive a superconducting energy-gap equation without the assumption that the Fermi energy is much larger than phonon energies. This equation is then approximated using two separate methods. The first method applies when the screened electron–phonon interaction is almost independent of wave vector and the Fermi energy is of the order of, or larger than, phonon energies. The gap equation obtained in this way takes account of the variation in the density of electron states with energy. The second approximation method applies when the screened electron–phonon interaction depends strongly on wavelength or when the Fermi energy is small compared to phonon energies. In this case, the gap equation takes account of the wave-vector dependence of the interaction, the wave-vector and frequency dependence of the electronic screening, the energy dependence of the density of states, and the wave-vector dependence of the superconducting energy gap. In addition, the effects of the retardation of the electron–electron interaction are included. (auth)

14727 VORTEX NUCLEATION IN A SUPERCONDUCTING SLAB NEAR A SECOND-ORDER PHASE TRANSITION AND EXCITED STATES OF THE SHEATH NEAR H_{c3}. Fink, H. J. (Atomics International, Canoga Park, Calif.). Contract AT(04-3)-701. Phys. Rev., 177: 732-7(Jan. 10, 1969).

A calculation is made as a function of slab thickness d of the critical field at which a second-order phase transition occurs, the point at which vortices nucleate in the slab ($d/\xi = 1.84$), and the size of the unit cell which contains one flux quantum (ξ being the coherence length). When $1.84 < d/\xi < 2.33$, there are two current loops of opposite circulation in one unit cell, and when $d/\xi > 2.33$, one of the current loops splits into two loops, each of which moves towards one of the surfaces as d/ξ is increased. The generalization of the order parameter near H_{c3} leads directly to Abrikosov's ansatz for the order parameter near H_{c2} when applied to bulk nucleation. The energies of the excited states of the surface sheath and the matrix elements for the transitions between the excited states and the ground state have been calculated. (auth)

14728 ULTRAHIGH CRITICAL FIELD IN SUPERCONDUCTORS WITH MAGNETIC IMPURITIES. Schwartz, Brian B.; Gruenberg, L. W. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., 177: 747-8(Jan. 10, 1969).

A superconductor containing magnetic impurities which couple antiferromagnetically to the conduction-electron spin offers the possibility of ultrahigh critical fields. A simple theoretical argument based on a molecular-field approximation is presented, and the conditions under which the high critical field is most likely to be observed are discussed. (auth)

14729 QUANTUM PHASE CORRELATIONS AND FLUCTUATIONS IN NARROW THIN-FILM SUPERCONDUCTORS. Hunt, T. K. (Ford Motor Co., Dearborn, Mich.). Phys. Rev., 177: 749-56(Jan. 10, 1969).

Measurements were made of the superconducting transition temperatures of very narrow thin films of tin. The transition temperatures of such narrow samples are depressed below those of wider sections of the same films by an amount which depends strongly on the characteristic dimensions of the samples. It is shown that previously published results as well as those of Parks and Groff et al. can be accounted for satisfactorily by a simple analysis, which considers the thermally induced fluctuations in the quantum-mechanical phase differences between two superconductors. In the previous work (Phys. Rev. Letters, 18: 551 (1967)), the direct connection of room-temperature measuring circuitry to the small samples led to effective noise temperatures of the order of 25°K, well above the sample temperature. In the present work, low-resistance shunts in parallel with the sample and immersed in the helium bath were used to isolate the sample from external fluctuations. When this precaution is taken, the observed values of ΔT_c show excellent agreement with the simple analysis proposed earlier. The determination of the undisturbed transition temperature T_{c0} by fitting the critical current data to the predicted $(T_{c0} - T)^{\frac{3}{2}}$ dependence yields values which are consistent with those obtained by simple measurement of T_c in a very wide section of the same film. Values of ΔT_c measured on a series of samples produced in a single evaporation and having the same width, but different lengths, show that the apparent dependence of ΔT_c on sample resistance reported by Groff et al. for samples in which all the dimensions were varied is not generally obeyed. Variation of R by two orders of magnitude in such a series produced no significant change in ΔT_c, in agreement with the earlier Hunt–Mercereau analysis. (auth)

14730 THERMAL CONDUCTIVITY OF In–Pb ALLOYS DOWN TO 0.4°K. Fox, G. T.; Wolfmeyer, M. W.; Dillinger, J. R. (Univ. of Wisconsin, Madison). Phys. Rev., 177: 756-7(Jan. 10, 1969).

Measurements on two indium–lead samples show a thermal-conductivity maximum or plateau region near 1°K for the superconducting case which is caused by the transition from phonon scattering by electrons to a combination of boundary and point-defect scattering. (auth)

14731 VORTEX FLUCTUATIONS IN SUPERCONDUCTING THIN-FILM BRIDGES. Thiene, Paul; Zimmerman, J. E. (Philco–Ford Corp., Newport Beach, Calif.). Phys. Rev., 177: 758-62(Jan. 10, 1969).

The convection of the self-field vortices into the interior of a superconducting thin-film bridge is shown to generate a shot-noise voltage as well as a steady-state voltage. A basic relation is developed between the time correlation function for fluctuations in bridge voltage and the space correlation functions for the vortex number densities. Vortex motion is treated by a rudimentary plasma-dynamic model, and the results are used to derive a practical expression for the spectral intensity of the noise voltage. (auth)

14732 INVESTIGATIONS OF THE PROXIMITY EFFECT BY ELECTRON TUNNELING. Adkins, C. J.; Kington, B. W. (Royal Society Mond Lab., Cambridge, Eng.). Phys. Rev., 177: 777-86 (Jan. 10, 1969).

The proximity effect in the Ag/Pb, Cu/Pb, and Sn/Pb systems was investigated by electron tunneling. A well-defined gap structure is induced in the normal metals by contact with the superconductor and, in tin below its transition temperature, the gap is augmented by the proximity of the lead. The results are in reasonable agreement with a theory of McMillan's and indicate electron transmission coefficients at the Ag/Pb, Cu/Pb, and Sn/Pb interfaces of about 0.1, 0.1, and 0.5, respectively. (auth)

14733 DETERMINATION OF e/h, USING MACROSCOPIC QUANTUM PHASE COHERENCE IN SUPERCONDUCTORS. I. EXPERIMENT. Parker, W. H. (Univ. of Pennsylvania, Philadelphia); Langenberg, D. N.; Denenstein, A.; Taylor, B. N. Phys. Rev., 177: 639-64(Jan. 10, 1969).

The fundamental physical constant e/h has been experimentally determined with high accuracy, using the ac Josephson effect in systems of weakly coupled superconductors (Josephson junctions). The measurement depends on the validity of the Josephson frequency-voltage relation $\nu = 2eV/h$, which relates the frequency of the oscillating supercurrent between two weakly coupled superconductors to the potential difference between them. The frequency–voltage ratio was measured using two effects: (a) constant-voltage steps induced in the dc current–voltage characteristics of Josephson junctions by microwave radiation and (b) microwave radiation emission by Josephson junctions biased at nonzero voltages. The ratio was found to be independent of the type of superconductor and the type of Josephson junction used, nonlinear harmonic and subharmonic effects, temperature, magnetic field, and microwave power and frequency. These results justify confidence in the general validity of the Josephson frequency–voltage relation and in the identification of the frequency–voltage ratio with 2e/h. The final experimental result, $2e/h = 483.5976 \pm 0.0012$ MHz/μV_{NBS} (standard deviation), referred to the volt as maintained by the U. S. National Bureau of Standards prior to January 1, 1969. The result in terms of the NBS volt as main-

tained after this date, V_{69NBS}, is 483.5935 ± 0.0012 MHz/μ_{69NBS}. (auth)

14734 NUCLEATION OF SUPERCONDUCTIVITY ABOVE H_{c3}. Fink, H. J. (Atomics International, Canoga Park, Calif.). Contract AT(04-3)-701. Phys. Rev., 177: 1017-18(Jan. 10, 1969).

The recent calculations of van Gelder concerning an upper critical field $H_{c4} > H_{c3}$ for a wedge-shaped specimen are discussed in the light of the surface-nucleation field of a slab of finite thickness. It is shown that H_{c4} is not a new critical field and that it is related to the size-dependent surface-nucleation field. (auth)

14735 KRIOGENNAYA TEKHNIKA. (Cryogenic Engineering). Fastovskii, V. G.; Petrovskii, Yu. V.; Rovinskii, A. E. Moscow, Energiya, 1967. 414p.

New areas in the application of cryogenics are examined: electrical and radio engineering, nuclear physics, and vacuum and rocket engineering. Methods of obtaining low temperatures are described and modern installations for the liquefaction of hydrogen and helium are discussed. Miniature cryogenic installations are described. Among the other topics discussed are the following: characteristic features of basic types of heat insulation and containers for storing and transporting liquefied gases, specific problems of heat transfer at low temperatures, methods of measuring temperatures and the level of cryogenic liquids, and the properties of basic construction materials at low temperatures. (ATD)

14736 KAPITZA RESISTANCE. Pollack, Gerald L. (Michigan State Univ., East Lansing). Rev. Mod. Phys., 41: 48-81 (Jan. 1969).

Kapitza resistance (R_K) is the thermal boundary resistance which occurs at the interface when heat flows from a solid into liquid helium. This review attempts a comprehensive presentation of experimental and theoretical knowledge since the discovery of Kapitza resistance in 1941. The experiments discussed and data presented include measurements of R_K at interfaces between liquid ^{4}He and: copper, lead, mercury, tin, indium, nickel, constantan, gold, silver, platinum, tungsten, silicon, quartz, lithium fluoride, and sapphire. The experiments between solids and liquid ^{3}He are also discussed. The treatments include discussion of the dependence of R_K on these variables: temperature, pressure, surface structure and preparation, and elastic properties of the solid. The principal experimental problems are associated with the surface properties, so these are discussed in detail. The principal theoretical discussion is of the acoustic impedance theory, following Khalatnikov and Mazo and Onsager, and the results are compared with the experiments. Modifications of the theory connected with improved matching at the interface, due, for example, to condensed He are also considered. When the theory is applied to interfaces between metals and liquid He, then it must be modified to take into account phonon electron interactions. The theory gives a temperature dependence $R_K \propto T^{-3}$, which is approximately what is experimentally observed. However, the observed R_K's are usually an order of magnitude or more smaller than theoretical values. The source of the disagreement lies either in a lack of knowledge of the surface physics or in another, dominant, mechanism for thermal energy exchange across the interface. Evidence for each possibility and some suggestions aimed at resolving the discrepancies are offered. (auth)

14737 EFFECTS OF STRESS AND STRUCTURE ON CRITICAL CURRENT DENSITIES OF SUPERCONDUCTING V_3Si. Brand, R.; Webb, W. W. (Cornell Univ., Ithaca, N. Y.). Solid State Commun., 7: 19-21(Jan. 1969).

It was found that suppression of the martensitic transition from cubic to tetragonal structure by application of uniaxial stress decreases the critical current density in V_3Si single crystals. (auth) (UK)

14738 NUCLEAR RELAXATION IN LIQUID SOLUTIONS OF HELIUM ISOTOPES. Grigor'ev, V. N.; Esel'son, B. N.; Masimov, E. A.; Mikhailov, G. A.; Novikov, P. S. (Physical-Technical Inst., Kharkov). Zh. Eksp. Teor. Fiz., 56: 21-4(Jan. 1969). (In Russian).

The spin–lattice relaxation times (T_1) in pure ^{3}He and in ^{3}He–^{4}He solutions are measured at temperatures between 1.4 and 2.1°K and ^{3}He concentrations between 20 and 100%. The measurements are performed by the nuclear magnetic resonance technique. A weak temperature dependence of T_1 is observed. With increase of temperature, the relaxation times increase. It is shown that addition of ^{4}He to ^{3}He increases the relaxation times. The results qualitatively are in good agreement with the Blombergen, Purcell and Pound theory. (auth)

Plasma and Thermonuclear Physics

Refer also to abstract 14932.

14739 (LA-4075) STATUS REPORT OF THE LASL CONTROLLED THERMONUCLEAR RESEARCH PROGRAM FOR 12-MONTH PERIOD ENDING OCTOBER 31, 1968. (Los Alamos Scientific Lab., N. Mex.). Jan. 15, 1969. Contract W-7405-eng-36. 121p. Dep. CFSTI.

ARGON—plasma of, diagnosis in Columba Z-pinch, (E)
DEUTERIUM—plasma of, diagnosis in Columba Z-pinch, (E)
PINCH DEVICES—development of fast Z, (E/T)
—plasma diagnostics in Columba Z, argon and deuterium, (E)
—plasma radial stability in Columba, (T)
—development of continuous flow Z, (E/T)
—plasma stability in toroidal Scyllac, (E/T)
—plasma diagnosis in Scylla 1A, halo, (E)
—electrode spark gap development for Scylla, three, (E)
—switch development for Scylla, crowbar, (E)
PLASMA—diagnostics in Columba Z-pinch, argon and deuterium, (E)
—stability in Columba Z-pinch, radial, (T)
—injection into transverse magnetic fields, (E)
—stability of Scyllac toroidal theta-pinch, (E/T)
—diagnostics in Scylla 1A toroidal theta-pinch, (E)
—heating of, electron cyclotron, (E)
—radiations from upper hybrid resonance electrons, (E/T)
—stability in quadrupole devices, (T)
—simulation of, research on, (T)
PLASMA ACCELERATORS—development of continuous flow pinch, (E/T)
—jet diagnosis in coaxial snowplow discharges, (E/T)
—gas valves for high pressure operation, development of
PLASMA JETS—diagnostics in coaxial snowplow discharges, (E/T)
SWITCHES—development of crowbar, for Scylla devices, (E)
THERMONUCLEAR REACTORS—development of continuous flow pinch, (E/T)
—development of quadrupole injection, with shielded supports
—plasma stability in quadrupole, (T)
VALVES—development of gas, for use with plasma guns (M.O.W.)

Confinement and Heating

Refer also to abstracts 14534 and 14700.

14740 (NP-17762) STUDIES OF QUASI-STEADY ELECTRIC FIELDS AND PLASMA OSCILLATIONS IN A STELLARATOR L-1. Preprint No. 96. Berezhetskii, M. S.; Grebenshchikov, S. E.; Kossyi, I. A.; Nechaev, Yu. I.; Robinovich, M. S.; Sbitnikova, I. S.; Shpigel', I. S. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). 1968. 26p. (In Russian). Dep. CFSTI.

Containment of low-pressure noncollisional plasma and processes responsible for plasma escape from the trap are investigated. Quasi-steady electric-fields and plasma oscillations induced by external injection and their relation to the plasma lifetime were studied using a two-inlet (l = 2) Liven'-1 stellarator. Data obtained indicated influence of the structure of magnetic surfaces on plasma diffusion. Moreover, the influence was exerted not only by the confining surfaces themselves, but also, by their fine structure. The appearance of magnetic discontinuities affected macroscopic plasma parameters (confinement time and potential). The plasma lifetime in the L-1 stellarator depends on precession of the field lines and the increases sharply with the growth of helical field up to the torsion angle $L = \pi/2$. The experiments did not reveal the cause of increased plasma diffusion in the L-1 stellarator, but they confirmed the importance of the stellarator magnetic field and magnetic surface fine structure on confinement of plasma. (R.V.J.)

14741 (NYO-3863-11) QUARTERLY PROGRESS REPORT [ON EXPERIMENTS ON MARK II TORUS EXPERIMENT], SEPTEMBER 26, 1968–DECEMBER 26, 1968. (Avco-Everett Research Lab., Everett, Mass.). Jan. 1969. Contract AT(30-1)-3863. 12p. Dep. CFSTI.

During this quarter the principal emphasis has been placed on improving the operation of the Mark II torus experimen. whose initial operations were described in the October 1968 Quarterly Progress Report. A description is given of work to improve electron injection. (M.O.W.)

14742 CONTRIBUTION TO THE THEORY OF MAGNETIC PUMPING OF AN INHOMOGENEOUS COLLISIONAL PLASMA. Nemov, V. V.; Stepanov, K. N. (Inst. of Physics and Tech., Kharkov). Nucl. Fusion, 8: 133-43(Oct. 1968).

The heating of a radially nonuniform plasma cylinder of nonuniform radius located in a longitudinal, constant, and uniform magnetic field B by magnetic pumping is considered. An oscillating magnetic field having the form of a traveling wave with phase velocity ω/k of the order of the ionic thermal velocity is produced by means of external azimuthal electric currents. The frequency of the oscillating field ω is significantly less than the reciprocal of the ion–ion collision time $1/\tau_i$ and the ion cyclotron frequency ω_i, the plasma electrons are magnetized (the electron cyclotron frequency is considerably greater than the reciprocal of the electron–electron collision time), and the plasma pressure is significantly less than the magnetic pressure. Simple expressions are obtained for the energy absorbed per unit time by the plasma as a result of dissipative effects: ion viscosity and longitudinal electronic heat conduction (Joule losses play a minor role in magnetic pumping). Particular attention is paid to the case of acoustic resonance, where the inhomogeneous plasma contains a layer in which the velocity of sound is equal to the phase velocity of the excited wave. In this situation the absorption of energy by the plasma increases sharply and the increase in plasma temperature T is determined to within an order of magnitude by the relation $dT/dt \sim \omega T(\tilde{B}/B)^2$, where $\tilde{B}$ is the amplitude of the oscillating magnetic field at the axis. (auth)

14743 THREE-TURN HELICAL MAGNETIC CONFIGURATION WITH SHEAR AND MINIMUM B. Aleksin, V. F.; Sebko, V. P. (Inst. of Physics and Tech., Kharkov). Nucl. Fusion, 8: 145-51(Oct. 1968).

The magnetic configuration of a three-turn helical magnetic field through which an axial current flows and which has three spatial magnetic axes is investigated. It is shown that, near the spatial axes, the cross sections of the magnetic surfaces are ellipses lying in the planes perpendicular to the axes. The parameter values for which the configuration concerned possesses, near one of the spatial axes, an angle of torsion of the magnetic field lines, shear, and minimum average magnetic field is considered. (auth)

14744 CUSP CONTAINMENT AND THERMONUCLEAR REACTORS. Spalding, I. J. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Nucl. Fusion, 8: 161-71(Oct. 1968).

Existing theories of the cusp containment of quiescent plasma are reviewed. Some technical and economic requirements of any fusion reactor are then summarized and used to deduce the probable dimensions of open-ended high-β reactors. It is shown that such reactors must be long, pulsed, and of very high output power. Crucial physical problems are the microstability of the high-β plasma boundary and, to a lesser extent, problems associated with energy transport by hot electrons. Assuming that these physical and technological problems are capable of solution, it is shown that mirror-symmetric versions of the hybrid-cusp discussed previously by Bickerton may have significant advantages over the simpler linear θ-pinch geometry. (auth)

14745 SCREENING OF A HIGH-DENSITY PLASMA FROM NEUTRAL GAS PENETRATION. Lehnert, B. (Royal Inst. of Tech., Stockholm). Nucl. Fusion, 8: 173-81(Oct, 1968).

In several experiments on a magnetically confined plasma and under certain conditions of a fusion reactor in stationary operation, neutral gas will be present in the regions surrounding the plasma. The inflow of neutrals and the outflow of plasma by diffusion or free streaming is studied in this paper, both for closed- and open-ended systems: (i) In a closed bottle neutral gas will not be able to penetrate through the cool boundary layers into the hot core of a high-density plasma. At plasma densities above 10^{21} m^{-3} the energy losses from interaction with the neutrals become negligible compared to the thermonuclear power production, but not at densities below 10^{19} m^{-3}. This is due to the fact that the penetration depth of the neutrals depends on the ionization rate and becomes about 10^{-2} and 0.1 m at the densities 10^{21} and 10^{19} m^{-3}. Further, the neutral gas inflow will be delayed by diffusion through a cool boundary region of sufficiently high density. In stationary operation the plasma density will be determined by the magnetic field strength and the density of the surrounding neutral gas. A condition for stable heat balance in a boundary region of finite thickness is deduced. (ii) As an alternative to a fusion device where the plasma is surrounded by an ultra-high vacuum region, it is therefore possible to surround a high-density plasma by a neutral gas blanket. The latter should be dense enough for released wall impurities to diffuse only slowly toward the plasma boundary. With a superimposed stream of neutral gas along the plasma boundary, the impurities can then be removed before reaching the plasma. (iii) In an open-ended system, thin layers of neutral gas are formed by plasma particles which escape along the magnetic field and recombine at the end walls. (iv) The theory agrees with measurements of the density of a fully ionized plasma as a function of the applied magnetic field and the density of the surrounding neutral gas. It also suggests that Bohm diffusion has not been present in earlier experiments with rotating plasmas where the density was found to decay at a very slow rate during free-wheeling. (auth)

14746 NONLINEAR CONFINING AND DECONFINING FORCES ASSOCIATED WITH THE INTERACTION OF LASER RADIATION WITH PLASMA. Hora, Heinrich (Westinghouse Research Labs., Pittsburgh). Phys. Fluids, 12: 182-91(Jan. 1969).

The nonlinear interaction of an intense light wave with an inhomogeneous plasma produces a macroscopic motion. A rigorous treatment of this interaction based on the ponderomotive force description leads to a general equation of motion. In a plasma with collisions and high electron density, the resulting force density can be interpreted as an expression of the radiation pressure. Below special densities there results a nonlinear collisionless force whose direction is toward decreasing density, and which produces a deconfinement. The magnitude of this force has a polarization dependence only in the third-order terms of the spatial dependence of the density. The total deconfining recoil momentum transferred to the inhomogeneous transition layer is evaluated. The theory of the nonlinear collisionless acceleration is used to explain the experimentally observed properties of the fast part of plasmas produced by lasers from isolated single small aluminum balls and thick solid targets. (auth)

14747 TOROIDAL THETA PINCH COLLAPSE BY THE SNOWPLOW MODEL. Itoh, Satoshi; Fujisawa, Noboru; Yamamoto, Kenzo (Nagoya Univ., Japan). Phys. Fluids, 12: 220-4 (Jan. 1969).

Accurate equations for the cross section of the toroidal theta pinched plasma column are derived using the snowplow model, and then are solved numerically to study the shift of the column position and the deformation of the cross section during the collapse. The column shifts towards the outer wall and the shape of the cross section changes from the initial circle into a heart as the collapse proceeds. The shift and the deformation, however, are not serious, if the aspect ratio is larger than 10. (auth)

14748 SINGLE-PARTICLE CONFINEMENT STUDIES IN A RADIO-FREQUENCY-SUPPLEMENTED MAGNETIC MIRROR. Eubank, H. P. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Phys. Fluids, 12: 234-40(Jan. 1969).

An experimental study of electron confinement in magnetic mirror geometry supplemented with rf quasi-potential barriers yields confinement times which appear to be a function of gas scattering only. Under minimum scattering conditions ($p \approx 5 \times 10^{-8}$ torr), 10- to 20-eV electrons are observed to undergo several thousand reflections before loss occurs. The magnitude of the quasi potentials and the conditions for onset of nonadiabatic particle behavior are found to be in good agreement with existing theory. (auth)

14749 SUPPRESSION OF ∇ B DRIFT IN CURVED THETA PINCH. Goldman, L. M.; Hurwitz, H. Jr.; Kilb, R. W. (General Electric Research and Development Center, Schenectady, N. Y.). Phys. Fluids, 12: 257-8(Jan. 1969).

Introduction of a conducting ring transverse to the axis of a curved theta pinch and inside the vacuum tube creates an equilibrium position for the plasma on the curved theta-pinch axis. (auth)

14750 IMPROVED PLASMA CONFINEMENT IN A Q MACHINE WITH SYMMETRICALLY HEATED END PLATES. Jassby, D. L.; Motley, R. W. (Princeton Univ., N. J.). Phys. Fluids, 12: 258-60(Jan. 1969).

The limiting confinement time of cesium plasma in a Q device has been increased from 20 to 50 msec by making the end-plate isotherms circular and concentric. (auth)

14751 CLASSICAL DIFFUSION OF A STATIONARY TOROIDAL PLASMA. Johnson, John L.; von Goeler, S. (Princeton Univ., N. J.). Phys. Fluids, 12: 255-6(Jan. 1969).

The Pfirsch–Schlüter factor, which measures the enhancement of diffusion due to current along the magnetic field over that associated with diamagnetic current, is calculated for general configurations and applied to specific ones including multipoles. (auth)

14752 TIME-DEPENDENT MAGNETIC FIELDS OF AN INJECTED HELICAL CURRENT. Cooper, Richard K. (Univ. of California, Livermore). J. Appl. Phys., 40: 517-24(Feb. 1969).

The electromagnetic field as a function of time in a conducting, infinitely long cylindrical tank into which a helical current is injected is considered. The longitudinal component of the magnetic field is treated in complete detail, and a plot of magnetic field vs time is given for the circularly symmetric case with parameters closely approximating the Astron configuration. (auth)

Diagnostics

Refer also to abstract 14825.

14753 MEASURING OF THE THERMAL CONDUCTIVITY OF HYDROGEN BETWEEN 2000 AND 7000°K. Behringer, K.; Kollmar, W.; Mentel, J. (Technische Hochschule, Munich). Z. Phys., 215: 127-51(1968). (In German).

Experimental and theoretical investigations have been performed to determine the thermal conductivity of hydrogen in the temperature range between 2000 and 7000°K. For this purpose the radial temperature distributions for various currents and the E–I characteristic of a low-current wall-stabilized hydrogen arc have been measured. In the dark region of the arc outside the bright core the temperature and the thermal conductivity between 2000 and 4500°K were found by means of the schlieren technique. The electron temperature in the core of the arc results from spectroscopic measurements. The gas temperature has been calculated with a formula, derived from the kinetic theory of gases. Assuming a constant collision integral Q^{11}_{el}, the radial distribution of electric conductivity has been calculated according to Langevin's formula. The value $Q^{11}_{el} = 30 \cdot 10^{-16}$ cm^2 results by comparing the integrated conductance with the measured one. Since now the radial distribution of power input and the temperatures are known, the thermal conductivity between 4500 and 7000°K can be determined as well. The total course of the thermal conductivity shows a strong peak at the temperature of 3740°K, characteristic for the dissociation process. (auth)

14754 PLASMA DIAGNOSTICS BY RADIOPROBE WITH FLOATING POTENTIAL. Godyak, V. A.; Kuzovnikov, A. A. Radiotekh. Elektron., 12: 557-60(Mar. 1968). (In Russian).

A method for measuring plasma density using the effect of the driving frequency on the plasma Langmuir probe current is given. An expression for the plasma density is derived as a function of the driving frequency amplitude and floating potential. The observed density (detected by measuring the probe current increase) was found to agree with measurements by other methods. The electron temperature can also be measured by this method. The method is distinguished by its simplicity and reliability. It is useful for work with transient plasmas (since the formation of the double layer takes place in approximately one ion plasma frequency period) and the plasma disturbance is minimized. It has an advantage over the Langmuir probe, since very dense plasma measurements can be made due to the absence of heating by large currents required in the standard Langmuir probe measurements. (ATD)

14755 X RAYS FROM A LASER-CREATED DEUTERIUM PLASMA. Bobin, J. L.; Floux, F.; Langer, P.; Pignerol, H. (CEA, Villeneuve-St.-Georges, France). Phys. Lett., 28A: 398-9(Dec. 30, 1968).

X-rays are detected through calibrated absorbers. Assuming a bremsstrahlung emission, evidence of electron temperature up to 120 eV is shown. (auth)

14756 CALCULATION OF THE ELECTRICAL CONDUCTIVITY OF A FULLY IONIZED PLASMA IN A MAGNETIC FIELD. Kolley, W. (Karl-Marx-Univ., Leipzig). Phys. Lett., 28A: 450-1(Dec. 30, 1968).

The electrical conductivity of a two-component plasma in a magnetic field is calculated on the basis of the Vlasov equation supplemented by complete Bhatnagar–Gross–Krook collision terms. (auth)

14757 ELECTRON CONDUCTIVITY IN HIGH MAGNETIC FIELDS BY THE TEST-PARTICLE TECHNIQUE. Benford, Gregory (Univ. of California, Livermore); Rensink, Marvin; Rostoker, Norman. Phys. Rev., 178: 382-9(Feb. 5, 1969).

The test-particle formalism of Rostoker is applied to electrons which move only in one dimension through randomly distributed, singly charged ions. This model is appropriate to the limit of infinite magnetic field. The test-particle equations are solved to find the conductivity $\sigma(\bar{k},\omega)$ for arbitrary wave number $\bar{k}$, neglecting electron–electron correlations. In the long-wavelength limit $k = 0$ the result agrees with previous work. Explicit expressions are then found for $\sigma(\omega)$, using degenerate statistics for the electrons. Contributions emerge both from excitation of undamped normal modes and from nonresonant individual particle scattering. For finite magnetic fields the cyclotron motion of the electrons is important, and the corrections to the one-dimensional model are analyzed when ω is comparable to ω_c. Further corrections for higher frequencies or lower magnetic fields may be obtained by a straightforward procedure. (auth)

14758 EXPERIMENTAL INVESTIGATION OF STARK BROADENING IN H_α. Birkeland, J. W.; Oss, J. P.; Braun, W. G. (Aerospace Research Labs., Wright-Patterson Air Force Base, Ohio). Phys. Rev., 178: 368-72(Feb. 5, 1969).

The profiles of the Balmer lines H_α and H_β, emitted in a vortex-cooled hydrogen arc, were measured over a temperature range of (1.0 to 1.6) $\times 10^{4}$°K and an electron density range of (0.6 to 1.6) $\times 10^{17}$ cm^{-3}. The observed H_α profiles are compared with the recent theoretical calculations of Kepple and Griem (from which the electron densities were inferred via the H_β half-widths), and those of Bacon and Edwards. The experimental and theoretical profiles are found to agree within their respective uncertainties although systematic differences are observed. (auth)

14759 CYLINDRICAL CAPACITOR AND ITS APPLICATION TO MEASUREMENTS ON CYLINDRICAL GAS DISCHARGES. Irish, R. T. (Royal Military Coll. of Science, Shrivenham, Eng.). Proc. Inst. Elec. Eng. (London), 116: 466-71(Mar. 1969).

The measurement of high electron densities within a plasma is often conveniently performed using microwave techniques, requiring a probing-signal frequency of the same order as the electron-plasma frequency. If the electron density is high, considerable cost and expertise are associated with this form of measurement. The device described is able to evaluate the electron density at a probing frequency much lower than the plasma frequency and thus eases the measurement considerably. For example, a tube, 10 cm bore, whose wall is 2-mm thick and is composed of material whose relative permittivity is 6, will enable electron densities at plasma frequencies of 12.5 GHz to be checked using a probing signal of only 1 GHz. (auth) (UK)

14760 SPECTROSCOPIC STUDIES OF A HELIUM PLASMA IN A LINEAR Z-PINCH TUBE. Ishii, Keishi (Kyoto Univ.). J. Phys. Soc. Jap., 26: 188-97(Jan. 1969).

In a linear z-pinch discharge of helium, the continuum emission at the maximum contraction of the plasma and some forbidden lines during the succeeding period of a few μsec were observed at the initial gas pressure of 6.0 torr. At the maximum contraction, the plasma was found to be a black body in the direction through the axis of the discharge tube and a gray body in the direction perpendicular to the axis. From the intensity of continuum and optical thickness, the temperature and the electron density have been determined to be $(1.5 \pm 0.2) \times 10^{4}$°K and $5 \sim 7 \times 10^{18}$ cm^{-3}, respectively. The intensity ratios of the forbidden lines to the allowed ones as well as their shifts were measured in $n^3L - 2^3P$ series. From these results, it has been proved that the electron density of the plasma changes from 1 to 0.1×10^{18} cm^{-3} in a few μsec after the maximum contraction. (auth)

14761 GREEN'S FUNCTION THEORY OF ATOMIC LINE BROADENING IN PLASMAS. Klein, Lewis (Howard Univ., Washington, D. C.). J. Quant. Spectrosc. Radiative Transfer, 9: 199-206(Feb. 1969).

A Green's function method is developed for the calculation of the line shape of the radiation from an atom in a plasma. It is shown that the width of the line is proportional to the imaginary part of the reciprocal of the dielectric function of the plasma. The theory includes electron correlations and quantum effects and thus results in convergent expressions for the line shape. It is also shown that for equilibrium plasmas no resonance in the line shape occurs at frequency separations equal to the plasma frequency. (auth) (UK)

14762 LANGMUIR PROBES COMPARED WITH OTHER DIAGNOSTIC TECHNIQUES IN A Q-DEVICE. Hashmi, M.; van der Houven van Oordt, A. J.; Wegrowe, J.-G. (Inst. for Plasma Physics GmbH, Garching, Ger.). Nucl. Fusion, 8: 197-201 (Oct. 1968).

A comparison of density measurements between cylindrical Langmuir probes, resonance fluorescence scattering and microwave methods is performed in a singly ionized barium plasma of a Q device by varying the following parameters: (1) density n: 3×10^{8} cm$^{-3} \leq n \leq 3 \times 10^{11}$ cm^{-3}; (2) plate temperature T_p: 2100°K $\leq T_p \leq$ 2500°K; (3) plate material: Re and W; (4) magnetic field B: 2 kG $\leq B \leq$ 8 kG; (5) mode of operation: double- and single-ended operations; (6) ion temperature T_i down to about room temperature, keeping the electron temperature $T_e \approx T_p$; (7) degree of ionization γ: 0.1% $\leq \gamma \leq$ 100%; (8) probe dimensions. If the density n is evaluated by equating the extrapolated ion saturation current I_s at the plasma potential V_s to the random ion current, it is shown that this yields a reliable relative value of the plasma density, which is by a factor of about 2.5 higher than the most probable value. (auth)

14763 RADIAL PROFILES OF CARRIER DENSITY AND ENERGY IN DIFFUSION CONTROLLED PLASMA. Chiplonkar, V. T.; Desai, Y. R. (Inst. of Science, Bombay). Physica, 35: 211-22(1967).

Radial variation of plasma particle density and energy for a cylindrical geometry has been studied in neon, argon, and air for the pressure range 140 to 3300 μ under steady-state conditions. Improved spatial resolution for the local plasma parameters, in the radial direction has been provided for. Good agreement of the observations with Schottky's theory is obtained when the boundary conditions provided by the experimental results are used. Electron energy remains fairly constant radially and the departure from the charge neutrality is found to be negligible. (auth)

14764 AUTOMATIC RECORDING AND ANALYSIS OF DOUBLE PROBE MEASUREMENTS IN PLASMA RESEARCH. Polman, J. (Rijksuniversiteit, Groningen, Netherlands). Physica, 34: 317-24(1967).

A new method for analysis of double probe characteristics is developed. These characteristics are recorded on punch tape, and their data are fed into a computer, which calculates both electron temperature and plasma density. Several methods of analysis of the characteristics in low pressure plasmas are compared. The determination of electron temperatures appears to be of good accuracy (10%). On the contrary, the absolute plasma density can only be determined roughly. For relative density measurements the probe technique gives satisfactory results. (auth)

14765 ELECTRON TEMPERATURE MEASUREMENTS IN A RADIO FREQUENCY GAS DISCHARGE. Polman, J. (Rijksuniversiteit, Groningen, Netherlands). Physica, 34: 310-16 (1967).

Some results of double probe measurements on electron temperatures in a radio-frequency hydrogen discharge (pressure 0.02 to 0.07 Torr) are reported. The probe characteristics, recorded on punch tape, were analyzed by means of a computer. A reasonable agreement between experimental values of the temperature and those calculated with aid of a modified Schottky theory was found. (auth)

14766 ION AND ELECTRON TEMPERATURE AND DENSITY BY THOMSON SCATTERING WITH A LOW RESOLUTION MONOCHROMETER. Siemon, Richard E.; Benford, James (Univ. of California, San Diego, La Jolla). Phys. Fluids, 12: 249-50(Jan. 1969).

Experimental results are presented which demonstrate the advantages of doing Thomson scattering with the Salpeter parameter α near unity. A simple method for determining T_i in this region with a low resolution monochrometer is described. (auth)

14767 COORDINATED MEASUREMENTS OF PLASMA DENSITY AND COOPERATIVE LIGHT SCATTERING IN A THETA-PINCH PLASMA. Daehler, Mark; Sawyer, G. A.; Thomas, K. S. (Los Alamos Scientific Lab., N. Mex.). Phys. Fluids, 12: 225-9(Jan. 1969).

Measurements have been made on the spectral broadening of ruby laser light scattered at a small forward angle by density fluctuations in a theta-pinch plasma, in order to systematically investigate the variations in scattering cross section with reverse bias magnetic field and with time during the first half-cycle of the compression field. Measurements of density under the same plasma conditions were made so that the effects of cross section variations could be separated from density variations. The principal results are: (1) The observed cross section is approximately six times the theoretical cross section for a plasma with the Scylla III temperature and density (no bias magnetic field). The large cross section is attributed to superthermal density fluctuations (turbulence) in the plasma. (2) The scattering cross section for a plasma with a bias field of −800 G is three times larger than for the plasma with no bias field. (3) There is little difference in the scattering cross sections measured at two times during the discharge. (4) The density measurements show a plasma loss rate which increases with increased reverse bias field. (5) There is a strong dependence of scattering on plasma temperature; the hotter the plasma, the smaller the scattering cross section and the broader the spectral width of the scattered light. (auth)

14768 ELECTRICAL CONDUCTIVITY OF PARTIALLY IONIZED NOBLE GASES. Nighan, William L. (United Aircraft Research Labs., East Hartford, Conn.). Phys. Fluids, 12: 162-71(Jan. 1969).

The electrical conductivity of the noble gases—argon, helium, xenon, and krypton—has been calculated for arbitrary degrees of ionization for electron temperatures in the 300 to 30,000°K range. A variational method elaborated by Robinson and Bernstein was employed in the calculations, along with the electron–atom momentum transfer cross-section values reported by Frost and Phelps. Because of the very low values of the electron–noble-gas atom cross sections near the Ramsauer minimum, Coulomb collisions have been found to influence the conductivity for values of fractional ionization as low as 10^{-7}. For the same reason electron–neutral momentum transfer collisions have been found to be unimportant for values of fractional ionization as low as 10^{-5}, above which the gas behaves as though it were fully ionized. Two limiting degrees of ionization have been defined for each noble gas above or below which the gas can be considered either completely or weakly ionized, respectively. In addition, the influence of electron–electron interactions on the electrical conductivity in the partially ionized regime has been established. (auth)

14769 INFLUENCE OF ELECTRON ATTACHMENT ON PROBE MEASUREMENTS. Tverdokhlebov, V. I. (Dnepropetrovsk Mining Inst., USSR). Zh. Tekh. Fiz., 38: 465-8(Mar. 1968). (In Russian).

The influence of electron trapping in the cold layer on measurements of the temperature of free electrons by the method of probe characteristics in the case of cylindrical probes, with allowance for electron diffusion is estimated. The dependence of the electron current density on the probe potential is determined under the assumption that the electron trapping process is a weak perturbation of the diffusion and transport of the electrons by the field. An analysis of this dependence has shown that the increase of the electron current in the probe with increasing probe potential follows not an exponential law, but a slower one. It is shown that the formation of a cooled layer near the probe inside the layer of molecules of an electronegative gas can lead to an overestimate of the electron temperature as determined by the probe-characteristics method. It is noted that probe measurements in a flame plasma should not be carried out with cooled probes, since trapping in the region cooled by the probe distorts the probe characteristics. (ATD)

14770 INFLUENCE OF IMPURITIES ON THE ENERGY OF FAST PARTICLES IN A COAXIAL SOURCE. Goncharenko, V. P.; Mishchenko, V. M. Zh. Tekh. Fiz., 38: 264-7(Feb. 1968). (In Russian).

This is a continuation of earlier work (Zh. Tekh. Fiz., 36: 85 (1966)) devoted to the influence of impurities on the acceleration of fast particles in a coaxial source, allowance for which is necessary in order to choose the optimal plasma-source parameters yielding the maximum velocity of the current layer and the maximum energy transformation coefficient. The mass and energy distribution of the ionic component of the plasma was analyzed with a Thomson mass spectrograph with a 20 kV drawing electric field. From 10 to 50 pulses were needed to obtain mass spectrograms with good photometric properties. To change the impurity content of the plasmoid, a mixture of working and impurity gases was introduced into the interelectrode region of the source, namely hydrogen with deuterium, helium, and nitrogen. The energy spectra of the fast hydrogen ions in these mixtures are determined, together with the dependence of the average energy of the hydrogen ions on the impurity content. It is noted that when the impurity content increases the energy range of the hydrogen ion broadens and the maximum of the energy distribution shifts towards larger energies, regardless of the nature of the impurity gas. An almost linear increase of the hydrogen-ion energy with increasing percentage of nitrogen is noted. The increase in the amount of the impurity gas leads to an increase in the energy of the lighter components, and the energy of the heavier hydrogen ions remains practically unchanged. Therefore the separation of the ion by masses in drift space should also increase. By the same token, this facilitates the problem of separating the impurities from the hydrogen. The increase of the hydrogen ion energy occurring when the heavy gas is added is attributed to the increase of the voltage occurring at the instant of the singularity. (ATD)

14771 MEASUREMENT OF TEMPERATURE BY CALORIMETRIC AND SPECTROMETRIC METHODS IN AN ARGON ARC PLASMA AT ATMOSPHERIC PRESSURE. Boffa, Cesare (Politecnico, Turin). Atti Accad. Sci. Torino. I. Cl. Sci. Fis., Mat. Natur., 102: 715-27(1967-68). (In Italian).

In a previous report by means of an enthalpy probe the local enthalpy values in an atmospheric argon arc plasma jet have been measured at different arc currents. Assuming that the plasma is in local thermodynamic equilibrium the temperature values have been evaluated. Spectrometric measurements of the temperature distributions (between 9.000 and 13,000°K) have also been made at the same values of the arc current and for four spectral lines. A comparison is made between the spectrometrically determined temperatures and those evaluated from local enthalpy measurements; informations are obtained about the local thermodynamic equilibrium in the plasma and in particular about the critical range of the arc current values in which deviations from local thermodynamic equilibrium occur. (auth)

Kinetics (General)

Refer also to abstracts 14577 and 14661.

14772 (ORNL-tr-2067) ON THE THEORY OF CONDUCTIVITY OF ELECTROLYTES AND WEAKLY IONIZED PLASMAS. [PART] I. Kremp, D. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from Ann. Phys. (Leipzig), (7) 18: 237-45(1966). 9p. Dep. CFSTI.

An abstract of the original German article appeared in NSA Vol. 21, abstract number 18723. (L.M.T.)

14773 THERMODYNAMICS OF DENSE PLASMA. Seryakov, K. I. (Inst. of High-Temperatures, Moscow). Teplofiz. Vys. Temp., 6: 749-50(July-Aug. 1968). (In Russian).

Equations describing the influence of charged-particle interactions on plasma thermodynamic properties were extrapolated. Studies were confined to thermodynamic stability of plasma consisting only of electrons and singly charged ions. Assuming that $\bar{p} = p/p_{crit}$ and density $\bar{n} = n/n_{crit}$ where p_{crit} is the pressure at temperature when $\bar{n} = \bar{n}_{crit}$, then $\bar{p} = 1.4\ n\ (1-0.3\ \bar{n}^{1/3})$ at $n = n_{crit}$ and $\bar{p} = 1.4\ \bar{n}\ (1-0.3\ \bar{n}^{1/3})$ at $\bar{n} = n_{crit}$. In the first case, the stability $\partial p/\partial V < 0$ is not true for $\bar{n} = 5\ (e^2)/p_D\ \kappa T = 4$; i.e., it reaches the supercritical point. In the second case the instability appears at $\bar{n} \approx 20\ (e^2)/p_D\ \kappa T \approx 7$. Graphs are also given of the effective ionization potentials as functions of electron density and temperature. (R.V.J.)

14774 EFFECTS OF VISCOSITY AND ELECTRICAL CONDUCTIVITY ON THE STABILITY OF A LIQUID MODEL OF HARD-CORE PINCH. Gokhale, M. H. (Tata Inst. of Fundamental Research, Bombay). Phys. Fluids, 12: 137-44(Jan. 1969).

The effects of viscosity and finite electrical conductivity of mercury on the axisymmetric instabilities of a current-carrying annular cylinder of mercury are considered in the context of the experiment of Lehnert and Sjögren. A straightforward numerical method to solve the characteristic value problems is used to determine the real values of growth rates for various values of the wave numbers and current density ratios, using true as well as hypothetical values of viscosity and electrical conductivity. It is shown that the consideration of neither the viscosity nor the electrical conductivity of mercury is adequate to remove a discrepancy between the experiment and an earlier theory by Jayasimha and Murty. It is shown that other parameters remaining the same, the viscosity of the fluid will have to be 10 times larger, or its electrical conductivity would have to be 10^7 times higher to reduce the growth rates to nearly half their values in the absence of viscosity and electrical conductivity. (auth)

14775 THE MOBILITY OF SIMPLE AND CLUSTER IONS IN ARGON AT HIGH PRESSURES. Popescu, Iovitzu; von der Heide, Ruediger (Univ., Kiel). Z. Phys., 220: 337-48(1969). (In German).

A time-of-flight technique is used for the measurement of positive ion mobilities in argon in the 1 to 100 atm pressure range at 300°K. The ions are produced by photoionization of gas atoms in the drift region with ultraviolet light from a spark discharge. A mobility is found which varies continuously with the reduced electric field E/p_0 and which exhibits two saturation values at 1.55 ± 0.01 cm²/volt sec (for $E/p_0 \gtrsim 2$ volt/cm torr) and at 0.818 ± 0.003 (for $E/p_0 \lesssim 0.17$). The former value is in excellent agreement with the zero-field mobility obtained by Beaty for Ar^+. The last value is interpreted in terms of the Langevin theory and connected with the formation of the Ar_{13}^+ labile cluster. This has the Ar^+ ion as nucleus and is surrounded by two complete shells of 12 and 20 argon atoms respectively. A mean value of the cluster radius is estimated as 6.24 Å. (auth)

14776 ALTERNATIVE DESCRIPTION OF THE NONLINEAR INTERACTION OF A PLASMA WITH A WEAK ELECTRON BEAM. Engelmann, F. (EURATOM-CNEN, Rome). Nuovo Cim., 59B: 177-86(Feb. 11, 1969).

As an application of the general theory described previously, the evolution of a weakly unstable, infinite plasma, with immobile ions, and without external fields, is studied for the so-called bump-in-tail case. It is shown that, in the quasi-linear approximation, the equations of motion of the electron distribution function and the spectrum of plasma waves are equivalent to the usual adiabatic formulation. The present approach yields the equation of motion for the plasma waves in the form of a diffusion equation in wave-number space. (auth)

Kinetics (Experimental)

14777 (AEC-tr-7015) INVESTIGATION OF THE MECHANISMS OF PLASMA JET CUTOFF BY TRANSVERSE MAGNETIC FIELDS. Gol'ts, E. Ya.; Khodzhaev, A. Z. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). Translation of report NP-17581. 34p. Dep. CFSTI.

An abstract for the original report appeared previously in NSA 22: 44114. (M.O.W.)

14778 (NIJS-P-224) CORRELATION OF LIGHT FLUCTUATIONS IN AN ARGON PLASMA OF THE POSITIVE COLUMN. Grabec, I. (Nuklearni Institut Jozef Stefan, Ljubljana (Yugoslavia)). Aug. 1968. 74p. (In Slavic). Dep.

Correlation coefficient of light fluctuations has been measured in an argon plasma in the positive column of glow discharge at gas pressure between 0.02 and 0.08 torr and at discharge current from 10 to 100 mA. At such conditions there are no striations. The mean frequency and mean wavelength of fluctuations were determined from correlation functions measured at time delay $\Delta t = 0$ and at zero distance between sensors, respectively. It has been found that the maximum of correlation coefficient envelope is moving towards the anode. The velocity of this movement has been determined. Approaching to some critical gas pressure at constant discharge current all these quantities change sharply and well observed ionization waves appear. (auth)

14779 THERMALIZATION OF THE KINETIC ENERGY OF A PLASMA FLOW BY A MAGNETIC MIRROR FIELD IN BSG-I EXPERIMENTS. Uchida, T.; Miyamoto, K.; Fujita, J.; Kawasaki, S.; Inoue, N.; Suzuki, Y.; Adati, K. (Nagoya Univ., Japan). Nucl. Fusion, 8: 263-7(Oct. 1968).

The purpose of the experiment using the BSG-I device described here is to study the expansion of a plasma, produced in a strong magnetic field by a theta pinch, into a weak magnetic channel and the thermalization of the kinetic energy of this plasma flow by a magnetic mirror field. The plasma, to which the fluid model is applicable, treated here is collision dominated and low-β. Shock phenomena due to the mirror field at the far end of the device are observed by several kinds of measurements and it was concluded that some part of the kinetic energy of the plasma flow was changed to thermal energy by the shock phenomenon. Plasma parameters measured in front of and behind the shock front were consistent with the Rankine–Hugoniot relations. Thus the ion temperature rises after the shock and approaches that of the initial plasma as produced in the theta pinch region before the expansion. (auth)

14780 DOMINANT SOURCE OF SOFT X RADIATION FROM COAXIAL DISCHARGE TUBES. Beckner, E. H.; Clothiaux, E. J.; Smith, D. R. (Sandia Lab., Albuquerque, N. Mex.). Phys. Fluids, 12: 253-4(Jan. 1969).

A detailed study was made of the spatial and spectral characteristics of x rays produced in a coaxial discharge tube. (auth)

14781 PLASMA FLUX TRANSPORT. Parkin, C. W.; Barach, J. P. (Vanderbilt Univ., Nashville). Phys. Fluids, 12: 250-2(Jan. 1969).

An electric shock tube has been used in an interaction experiment with a transverse, dc magnetic field. A simple magnetohydrodynamic analysis, assuming a conductivity of 130 mho/cm, emphasizes the importance of tensor conductivity and transverse field diffusion. (auth)

14782 DEFORMATION OF A NON-HOMOGENEOUS PLASMA FLUX UNDER THE ACTION OF PONDEROMOTOR FORCES. Lukyanchikov, G. S.; Raizer, M. D.; Frank, A. G. (Lebedev Inst. of Physics, Moscow). Zh. Tekh. Fiz., 38: 296-303(Feb. 1968). (In Russian).

This is a continuation of earlier work (At. Energ. 18: 14(1965)) and is devoted to an investigation of the interaction between a bounded plasma jet and a microwave field. The experiments were performed with a rarefied plasma under conditions when the frequency of the field was much higher than the frequency of the Langmuir oscillations, and the characteristic transverse dimension of the jet was much smaller than the wavelength. The deformation of the bounded plasma with inhomogeneous density was investigated for an interaction between a plasma jet and a standing H_{01} wave in a rectangular waveguide, and was revealed by the variation of the characteristic transverse dimension and the redistribution of the particle density over the cross section of the jet. In analogous measurements, but with the plasma jet passing through the node of the electric field and at the same value of the quasi potential (5 to 40 and 70 eV), no appreciable change of either the transverse dimension or the particle density distribution was observed. A theoretical approximate analysis of the interaction shows that the observed effect can be attributed to the action of ponderomotive forces occurring in a bounded plasma of inhomogeneous density. The distribution of these forces over the cross section of the jet is calculated as a function of the plasma

density, of the characteristic transverse dimension of the jet, and of the electric field intensity. (ATD)

14783 ELECTRIC-FIELD DISTRIBUTION IN PULSED HIGH-CURRENT-DENSITY DISCHARGES IN HELIUM AND HELIUM–HYDROGEN MIXTURES. Allario, Frank; Wainfan, Nathan (Polytechnic Inst. of Brooklyn). J. Appl. Phys., 40: 675-81(Feb. 1969).

The results of a study on high-current-density, pulsed glow discharges in He and He–H_2 mixtures are presented. These results trace the temporal development of the electric-field and wall-potential distribution appearing between the electrodes of a discharge tube as the discharges approach dynamic equilibrium. These discharges, of 1.3 microsecond duration, are sustained in 2.5-cm-diameter pyrex tubes with interelectrode gaps variable between 10 and 40 cm. The pressure range runs from 0.50 to 5.0 torr. As the discharge approaches dynamic equilibrium late in the discharge pulse, current densities of the order of 15 A/cm^2 are maintained. The buildup of the electric field in the vicinity of the cathode is determined by time-resolved measurements of the Stark splitting of lines in the helium and hydrogen spectrum. The axial component of the electric-field and wall-potential distribution in the rest of the discharge are obtained from signals induced on a series of externally placed electrostatic ring probes. Fields as high as 78 kV/cm were detected at the cathode face, while uniform fields of the order of 10 V/cm torr were found in most of the rest of the discharge. Comments are made on the transition region between high- and low-field regions in the discharge. (auth)

14784 SPECTROSCOPIC MEASUREMENT OF HIGH-FREQUENCY ELECTRIC FIELDS IN A PLASMA BY OBSERVATION OF TWO-QUANTUM TRANSITIONS AND SPECTRAL LINE SHIFTS. Cooper III, William S.; Ringler, Heinz (Univ. of California, Berkeley). Phys. Rev., 179: 226-36(Mar. 5, 1969).

Normally forbidden two-quantum transitions were observed in the optical spectrum of a helium plasma. These transitions were induced by applying a microwave field to a separately generated steady-state helium discharge. Measurements of the relative intensity and wavelength of the optical photons emitted in the two-quantum transitions $5^1F^0 \rightarrow 2^1P^0$ in He I determined both the frequency and the strength of the microwave field in the plasma. The field strength was also measured by observation of the Stark shift of a spectral line and by measurement of the microwave power input and the Q of the microwave cavity. All measurements of the field strength are in satisfactory agreement and indicate an rms microwave field strength in the plasma of about 215 V/cm. The spectroscopic measurement of the frequency of the microwave field is within 3% of the actual value, and the measured polarization of the radiation agrees with theory. (auth)

Kinetics (Theoretical)

Refer also to abstract 14830.

14785 (MATT-Trans-85) THEORY OF TRANSPORT PHENOMENA IN A PLASMA IN A STRONG MAGNETIC FIELD. Baklunov, V. A.; Silin, V. P.; Shister, A. R. Translated for Princeton Univ., N. J., from report NP-17761. 9p. Dep. CFSTI.

The five-moment approximation of the Grad method is used for obtaining the transport equations in a completely ionized plasma in a strong magnetic field when the Debye screening radius turns out to be greater than the Larmor electron radius. (M.O.W.)

14786 (UCRL-Trans-10323) RESONANCE PHENOMENA IN PLASMA AND FLUID FLOWS. Timofeev, A. V. Translated by T. Watt for Univ. of California, Lawrence Radiation Lab., Livermore, from Rezonansnye Yavleniya v Techeniyakh Plazmy i Zhidkosti, Kurchatov Institute of Atomic Energy, Moscow, 1968. 195p. Dep. CFSTI.

It is found that the stability and the oscillatory properties of flows in a continuous medium (plasma or ordinary fluid) are determined by phenomena which develop at resonance points at which the phase velocity of the wave is equal to the flow velocity. It is found that all the undamped proper oscillations are absent from the simplest plasma flows with sufficiently rapidly varying velocity profiles. In the theory of plane-parallel flows of an incompressible fluid, the analogous result is given by Rayleigh's theorem. (auth)

14787 KINETIC THEORY OF PLASMAS AND MATTER-RADIATION INTERACTION. III. INTERACTION BETWEEN INTENSE RADIATION AND A PLASMA BY THE INDUCED COMPTON EFFECT. Peyraud, J. (Faculte des Sciences, Orsay, France). J. Phys. (Paris), 29: 872-6(Oct. 1968). (In French).

Previous work is continued, wherein it was shown that the Compton interaction was not negligible for intense monochromatic radiation. Here, the main study is of the interaction between a plasma and a laser radiation. A shift to the low frequencies of the laser beam (photon momentum loss) and a heating of the electrons during the interaction between the plasma and the laser beam is predicted. The Compton effect and the inverse bremsstrahlung on the neutrals are compared qualitatively. (auth)

14788 STATIONARY SOLUTIONS OF THE VLASOV EQUATION WITH EXTERNAL ELECTRIC FIELDS AND BGK COLLISION TERMS. Christoph, G. (Deutsche Akademie der Wissenschaften zu Berlin, Leipzig). Phys. Lett., 28A: 395-6(Dec. 30, 1968).

For external periodically space- and time-dependent fields the first-order Fourier components of the internal field of a Vlasov plasma with collisions are calculated. (auth)

14789 INELASTIC BOLTZMANN EQUATION FOR SLIGHTLY IONIZED GASES. McCormack, Francis J. (Univ. of North Carolina, Greensboro). Phys. Rev., 178: 319-26(Feb. 5, 1969).

By expanding in a Taylor series the inelastic scattering probability in the collision term of the Boltzmann transport equation, an approximate form of the Boltzmann equation for slightly ionized gases in the presence of a time-dependent electric field, which takes into account elastic and inelastic electron–molecule collisions, is obtained in a rigorous fashion. The inelastic collision term is obtained for arbitrary collision frequency, and it is shown how this expression can be simplified under the assumption of a low inelastic (in comparison with the elastic) collision frequency, or low molecular excitation energy in comparison with the average kinetic energy of the electrons, or both. Making both these assumptions and further assuming a low inelastic energy transfer, a formal solution of this equation is affected by an iterative procedure. This solution indicates explicitly that inelastic collisions are responsible for a small correction term to the distribution which is obtained if one considers only elastic collisions. (auth)

14790 TRANSIT OF BEAMS OF CHARGED PARTICLES THROUGH A NON-ADIABATIC MAGNETIC FIELD. Jancarik, J. (Inst. of Plasma Physics, Prague). Czech. J. Phys., 19: 204-16(1969).

The possibility of obtaining beams of particles with high transverse energies in a strong magnetic field is discussed. The motion of particles in a weakly nonadiabatic field is described by a linear nonhomogeneous equation. The nonadiabaticity of motion is caused, in the first approximation, by the curvature of the magnetic lines of force. The conditions for a small spread of magnetic moments of the beam particles are established by solving the equation of motion. The transverse energy of particles and its spread can be varied by varying the shape of the magnetic field and the initial radial velocities of the particles. As a result of the conditions for a small spread of magnetic moments, a beam traversing a steep magnetic field gains a smaller magnetic moment than a beam passing through a field with a lesser slope. (auth)

14791 THE THERMODYNAMICS OF A COLLISIONLESS PLASMA AT EQUILIBRIUM IN A MAGNETIC FIELD. Minardi, E.; Santini, F. (EURATOM-FOM Association, Jutphaas, Netherlands). Physica, 35: 19-28(1967).

The free energy and entropy functionals describing the equilibrium of a collisionless low β plasma in a general adiabatic magnetic field are constructed following the rules described in previous articles. The close connection between the conditions ensuring the minimum entropy of a given equilibrium configuration and the negative energy variation in a general class of interchanges involving the magnetic energy is discussed. These conditions are expressed in a form which is invariant with respect to transformations between all possible curvilinear coordinate systems defined by the given external magnetic field. The conditions in the invariant form can be used for the calculation of the regions of minimum entropy, where the plasma should be expected to be unstable. (auth)

14792 KINETIC DESCRIPTION OF AN INHOMOGENEOUS PLASMA. Kuszell, A. (Univ. Libre, Brussels). J. Math. Phys. (N.Y.), 10: 210-20(Jan. 1969).

The general description of a strongly inhomogeneous one-component plasma in the so-called "ring" approximation is derived. Using the general theory of inhomogeneous systems, the closed system of two equations in one-particle phase space is obtained. The additional equation for some function, which appears in the collisions term, has the form of a Vlasov equation linearized around the inhomogeneous one-particle distribution function. The

meaning of the parameters which appear in this equation is discussed. This equation is solved in the hydrodynamic approximation. The collision operator in the Markoffian limit reduces to the well-known form. The velocity distribution function for the inhomogeneous state is discussed and some additional terms to the usual Balescu–Guernsey–Lenard equation, in the case of no square-integrable inhomogeneity factors, are obtained. The influence of initial correlation is discussed. (auth)

14793 GENERAL TREATMENT OF THE SHORT DISTANCE DIVERGENCE IN CLASSICAL TWO-COMPONENT PLASMAS. Dekeyser, R. (Instituut voor Theoretische Fysica, Louvain, Belgium). Physica, 35: 506-24(1967).

It is shown that a set of neighboring quantum states can be orthogonally transformed into a set of classically behaving localized packets, if their wave functions can be fairly well approximated by the WKB method and if they lie in a dense part of the energy spectrum. The distribution of the points of localization is the same as predicted by classical statistical mechanics. This is proved in one dimension and for a general spherical potential. It enables one to formulate a partly quantum-mechanical and partly classical description with a smooth transition in between. The short-distance correlation function for oppositely charged particles in a plasma is not easily calculated. (auth)

14794 TRANSPORT PROPERTIES OF ALMOST-LORENTZIAN MIXTURES. Sandler, Stanley I. (Univ. of Delaware, Newark); Mason, E. A. Phys. Fluids, 12: 71-7(Jan. 1969).

It is shown that the transport coefficients for an almost-Lorentzian mixture ($m_\beta/m_\alpha \ll 1$, $n_\beta/n_\alpha < 1$) can be computed as a perturbation to the coefficients for a true Lorentzian mixture, which are known exactly. This method of computation is found to be much more efficient than the usual Chapman–Enskog method. Application to partially ionized gases is discussed. (auth)

14795 TEMPERATURE RELAXATION NEAR THE INTERFACE OF TWO SEMI-INFINITE PLASMAS. Lin, Shao-chi; Wei, Hsin Yi (Univ. of California, San Diego, La Jolla, Calif.). Phys. Fluids, 12: 172-82(Jan. 1969).

The problem of electron–ion temperature relaxation when two semi-infinite, nonmagnetized plasmas at different initial temperatures were suddenly brought into thermal contact under constant pressure is investigated using the two-fluid model. No current is assumed to flow across the interface, and charge separation is considered only to the extent of a simple correction on effective thermal conductivity (i.e., no plasma oscillation). Viscous stresses associated with induced fluid motion are also neglected. The asymptotic solution for long time after thermal contact is shown to be identical to that in a single-temperature plasma, with effective thermal conductivity equal to approximately $[1 + (3m_e/m_i)^{1/2}]$ times the local electron thermal conductivity. For a time scale shorter than or comparable to the mean electron–ion collisional energy transfer time t_{ei} a self-similar solution is obtained in the form of a double series in ascending powers of the nondimensional time $\tau = t/t_{ei}$ and of the initial temperature difference parameter $\epsilon \equiv (T_2 - T_1)/(T_2 + T_1)$. It is found that the induced pressure is quite large at early times, suggesting that thermal shock could be a significant source of plasma wave excitation in certain non-steady problems. (auth)

14796 MINIMUM ENERGY PROPERTY OF A BOUNDED ONE-DIMENSIONAL PLASMA. Hohl, Frank (Langley Research Center, Hampton, Va.). Phys. Fluids, 12: 230-3(Jan. 1969).

Analytic and numerical methods are used to investigate the dynamics, stability, and approach to equilibrium of a bounded, collisionless one-dimensional plasma with a fixed neutralizing ion background. A class of stationary solutions of the nonlinear Vlasov equation is found which represents minimum energy states. It is found that the quasi-equilibrium state which is reached after several plasma periods is close to the Fermi distribution predicted by Lynden-Bell. (auth)

14797 TRANSPORT CROSS SECTIONS FOR SCREENED AND CUTOFF COULOMB POTENTIALS. Suchy, Kurt (Univ., Marburg, Ger.). Phys. Fluids, 12: 247-9(Jan. 1969).

The analytic expressions for the transport cross sections of a cutoff Coulomb potential agree with the numerical results of an exponentially screened potential if the cutoff radius is suitably related to the screening Debye–Hückel length and the Landau length. (auth)

14798 STRUCTURE OF A SHOCK WAVE IN A WEAKLY IONIZED PLASMA. Pataraya, A. D. (Inst. of Physics, Tbilisi, USSR). Zh. Tekh. Fiz., 38: 213-19(Feb. 1968). (In Russian).

The structure of a shock wave in a weakly ionized plasma consisting of atoms and ions with greatly differing masses was analyzed, aimed at determining the effects produced by the difference in the masses of the ion and of the neutral atom. The mixtures of He, Cs^+, e and Ne, Li^+, e were investigated. The plasma parameters were chosen such that in the first nonvanishing approximation there occurs in the thermal field a temperature change described by a formula derived with the aid of the energy equation and the equation of motion for the electron gas. The thermal layer in the leading part of the shock front is called the front thermal layer, and the one behind the shock front the rear layer. The calculations were performed for a model in which, at definite values of the plasma parameters and shock-wave velocity, the temperature of the electrons at the end of the front thermal layer is close to the temperature of the rear layer, and the electron temperature remains constant inside the shock front. It is also assumed that all the quantities characterizing the particles are discontinuous in the shock wave, with the exception of the electron temperature, while inside the shock front the density of the ions is equal to the density of the electrons. The relaxation coefficients in the effective cross sections of the interactions in the quasineutral plasma are calculated from the equation for the thermal conductivity of the electron gas. The electric field intensity in the thermal layers and in the shock-transition layer is obtained for the particles. It is noted that in the shock-transition layer the electric field consists of two terms, one connected with the separation of the charges by the inhomogeneity of the layer inside the shock front for the heavy particles and the other connected with the separation of the charges due to the collisions between the electrons and the neutral atoms. The electric field intensities and the temperatures of the thermal layers are determined. (ATD)

14799 INTERACTION BETWEEN A MODULATED BEAM AND PLASMA IN A MAGNETIC FIELD. Pyatak, A. I.; Shevchenko, V. I. (Physical-Technical Inst., Kharkov). Zh. Tekh. Fiz., 38: 482-8(Mar. 1968). (In Russian).

An analysis was made of the conditions for the excitation of oscillations when a density-modulated electron beam interacts with a plasma in a constant homogeneous magnetic field. The wavelength of the modulation is small compared with the wavelength of the excited oscillations. It is assumed that the beam is compensated, its density is a periodic function, and the beam and the plasma are unbounded and homogeneous in directions perpendicular to the direction of the magnetic field. A dispersion equation obtained for the case when the ions are at rest before the oscillations are excited yields the region of instability and the magnitude of the growth increment. The presence of strong modulation leads to a decrease of the maximum growth increment. Just as in the case of excitation of Langmuir oscillations, when a modulated beam interacts with a plasma, the regions of instability of the ion–sound oscillations become much narrower compared with the case of interaction of an unmodulated beam. The maximum increment also decreases if the distribution of the density in the beam is essentially inhomogeneous. (ATD)

14800 CYCLOTRON AND CHERENKOV MECHANISMS FOR EXCITING HYDROMAGNETIC RADIATION IN THE MAGNETOACTIVE PLASMA. Kato, Yoshio; Higuchi, Yoshihiro. Sci. Rep. Tohoku Univ., Fifth Ser., 19: No. 1, 1(1967).

Ray and group refractive indices derived for propagation of hydromagnetic waves in the magnetoactive plasma are applied to calculation of radiation emitted by a single charged particle gyrating with velocity V in the static magnetic field H_0. The hydromagnetic radiation is possible by cyclotron and Cherenkov mechanisms when proton velocity exceeds phase velocity of the emitted hydromagnetic waves. The relation can be found between the ratio of Alfvén wave velocity to proton velocity and that of the gyrofrequency of a proton to angular frequency of hydromagnetic waves if a particular value is assigned to the angle between the direction of propagation of waves emitted and proton velocity. Results are applied to hydromagnetic emission in a simple model of the magnetosphere. In order to emit the hydromagnetic waves in the frequency band of about 1 cps, the kinetic energy of a proton is required to be about 200 keV to 1 MeV for the cyclotron excitation and about 3 to 10 keV for the Cherenkov excitation in the vicinity of the equatorial plane at 4 R_E. (auth) (Geophys. Abstr.)

14801 GALERKIN'S METHOD UTILIZATION FOR SOME PROBLEMS OF POSITIVE COLUMN THEORY. Belousova, L. E. Zh. Tekh. Fiz., 38: 457-61(Mar. 1968). (In Russian).

A solution is presented of the differential equation for the electron density with account of ambipolar diffusion, volume recombination, direct and stepwise ionization, using the Galerkin method. An expression is obtained relating the coefficients of the direct ionization, volume recombination, and stepwise ionization with the coefficient of ambipolar diffusion, radius of the plasma column, and the electron densities on the axis and at the

wall. All the previously known relations are shown to be particular cases of this equation. The calculations obtained in this manner are compared with the known experimental data. (ATD)

14802 STATIONARY ELECTRIC ARC IN A NARROW SLIT CHAMBER. Kurkov, S. A. (All-Union Electrotechnical Inst., Moscow). Zh. Tekh. Fiz., 38: 309-17(Feb. 1968). (In Russian).

The purpose of the investigation was to obtain data for the design of slotted arc-extinction devices. Analytic equations are obtained relating the gradient of the voltage, the width of the slot, and the density of the current in the stationary arc, with allowance for the nonlinear dependence of the characteristics of the plasma on the temperature and for the inhomogeneity of the plasma temperature at different cross sections of the arc. The arc column was assumed to be homogeneous over its length, and the electric field intensity was assumed to be constant over the cross section of the arc. To find an expression for the average current density in the arc column, the principle of minimum voltage of the stationary electric arc is employed, and a heat exchange model is used, in which the influence of the wall on the real microkinetic processes in the arc plasma and in the boundary layer between the arc and the wall reduce only to maintenance of constant temperature on the surface of the arc. Certain examples of solving the obtained analytic equations are presented. (ATD)

14803 VARIATIONAL FORMULATION SPECIFYING THE BREAKDOWN CRITERIA FOR PLASMAS SUBJECTED TO SPATIALLY NONUNIFORM ELECTRIC FIELDS. Mayhan, Joseph T.; Fante, Ronald L. (Avco Missile Systems Div., Wilmington, Mass.). J. Appl. Phys., 40: 449-53(Feb. 1969).

A variational formulation of the breakdown criteria for plasmas subjected to spatially nonuniform electric fields is developed and applied to several examples. The method uses a different variational function than that developed previously by Epstein. The method is valid for both pulse and cw breakdown. Several examples are presented which illustrate the theory. Application of the formulation to breakdown in front of a narrow infinite slot radiator on a ground plane demonstrates that an effective diffusion length can be defined which is a function of the aperture width. (auth)

14804 EXCITATION OF AZIMUTHAL CURRENT DURING STATIONARY ROTATION OF A CONDUCTING LIQUID. Drobyshevskii, E. M. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekh. Fiz., 38: 381-3(Feb. 1968). (In Russian).

The influence of inertial forces on the excitation of azimuthal current in stationary rotation of a plasma is discussed. As a result of stationary motion of the plasma, a centrifugal drift of the charges takes place and causes an azimuthal electric current. The interaction of this current with the magnetic field prevents centrifugal spilling of the plasma. An expression is derived for the density of this current in the case of a magnetized plasma. When a conducting liquid is accelerated as a body, the electrons move with a certain delay, determined by the relaxation time. This delay is due to the action exerted on the ion component by forces that move the liquid, such as viscosity forces. As a result of the delay, the electron velocity can be smaller than the velocity of the ion component and an electric current appears. The magnitude of the effective electric field causing the current is determined by the Coriolis force acting on the electronic component. An expression is derived for this current. It is noted that at the same values of the macroscopic velocity, the density of the Coriolis current will be much larger if the accelerating forces act via the electronic component. The azimuthal current is excited by the Coriolis force independently of the presence of an external magnetic field. The results are illustrated with free rotation of an ionized plasma in a homopolar device and in the phenomenon of solar granulation as examples. (ATD)

14805 RELATIVISTIC CORRECTIONS TO THE CONDUCTIVITY OF A COLLISIONAL PLASMA IN A MAGNETIC FIELD. McBride, John B.; Pytte, Agnar (Dartmouth Coll., Hanover, N. H.). Phys. Rev., 179: 145-8(Mar. 5, 1969).

The electrical conductivity tensor of a many component, relativistic plasma in a constant magnetic field, and near equilibrium is obtained. The collision term in the kinetic equation is left arbitrary, and the collisional part of the conductivity tensor is expressed as a momentum integral over the collision term directly. As an application, the conductivity due to electron motion is calculated to first order in both the relativistic and thermal corrections with the Belyaev–Budker collision integral. The thermal corrections are the same as in the nonrelativistic theory. The leading contributions to the conductivity from the ion motion are also obtained to first order in the electron relativistic corrections. (auth)

14806 RADIAL DISTRIBUTION FUNCTIONS FOR A HYDROGENOUS PLASMA IN EQUILIBRIUM. Barker, A. A. (Univ. of Florida, Gainesville). Phys. Rev., 179: 129-34(Mar. 5, 1969).

Radial distribution functions $g_{ab}(r)$ for a dense hydrogeneous plasma ($n_i = n_e = 10^{18}$ electrons/cc) are obtained near the ionization temperature by solving the Percus–Yevick equation and a modified Percus–Yevick equation. The effective interparticle potentials used were obtained previously by a direct evaluation of their corresponding two-particle Slater sums, and include the Heisenberg quantal effect, but not the statistical quantal effect. The iterative solution of the equations, even using a variety of numerical procedures, is found to break down when the ionization falls appreciably. (auth)

14807 CONDUCTIVITY TENSOR OF A COLLISIONAL PLASMA IN A MAGNETIC FIELD. Pytte, Agnar (Dartmouth Coll., Hanover, N. H.). Phys. Rev., 179: 138-45(Mar. 5, 1969).

A general method is developed for the calculation of the conductivity tensor, collisional contribution included, associated with a wave in a plasma in a magnetic field. The method is based on an iterative procedure and is applicable to any kinetic equation. With the Landau collision term a result valid to all orders in $k^2\lambda_D^2$ is given in integral form, and the electron current contribution is calculated explicitly to order $k^2\lambda_D^2$. The leading contributions resulting from the ion motion are also obtained. (auth)

14808 PROPERTIES OF AN AFTERGLOW HELIUM PLASMA. Poukey, J. W.; Gerardo, J. B.; Gusinow, M. A. (Sandia Labs., Albuquerque, N. Mex.). Phys. Rev., 179: 211-26(Mar. 5, 1969).

The role played by individual atomic reactions and transport processes in the decay of a helium afterglow plasma in a long cylindrical vessel is studied by solving numerically a complete set of three-temperature transport equations. Comparison with the measured decay of a laboratory afterglow shows the equations to be realistic. Reactions which are found to be particularly important in determining the decay include electron–ion recombination, metastable formation, metastable–electron and metastable–metastable collisions, resonant charge exchange, and electron–ion collisions. The room-temperature wall bounding the plasma causes spatial gradients in the densities and temperatures to evolve, resulting in appreciable thermal conduction and particle convection. The relative importance of the various reactions and processes is presented quantitatively. Conclusions are reached which apply at least semiquantitatively to any afterglow helium plasma with densities, temperatures, and geometry comparable to those studied here. (auth)

Production

14809 (AEC-tr-7016) HOT PLASMA PRODUCTION DURING INJECTION OF CLUSTERS OF FAST ATOMS INTO MAGNETIC TRAPS. Kartashev, K. B.; Pistunovich, V. I.; Filimonova, E. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Atomnoi Energii). Translation of report IAE-1399. 24p. Dep. CFSTI.

An abstract for the original report appeared previously in NSA 22: 41622. (M.O.W.)

14810 (NYO-3578-10) PRODUCTION OF PLASMAS FOR THERMONUCLEAR RESEARCH BY LASER BEAM IRRADIATION OF SOLID PARTICLES. Semiannual Report, August 1, 1968–December 31, 1968. Haught, Alan F.; Polk, Donald H.; Fader, Walter J. (United Aircraft Corp., East Hartford, Conn. Research Labs.). Dec. 1968. Contract AT(30-1)-3578. 51p. (UARL-G-920365-10). Dep. CFSTI.

An experimental and theoretical investigation of the production of high-temperature, high-density, spherically expanding free plasmas and the interaction of these plasmas with magnetic containment fields of mirror, cusp, and minimum-B geometry are studied. Hydrodynamic and simplified integrated similarity models of the free plasma formation and development have been developed and give results for the plasma energy in good agreement with experimental measurements. Theoretical studies using the hydrodynamic model have examined the early plasma–magnetic field interaction, and show plasma deceleration, trapping, and thermalization of such plasmas formed within magnetic fields. Experimental studies of the interaction of these initially spherical, expanding plasmas with magnetic confinement fields of mirror and minimum-B geometry at field strengths up to 8 kG show that (1) in 5 kG or greater minimum-B fields the plasma is contained at densities $\geq 10^{13}$ cm^3 for as long as 10 μsec, (2) the major plasma loss is through the mirror loss cones, and (3) less than one percent of the plasma escapes across to the magnetic field with minimum-B fields of 5 kG or greater. Microwave measurements of the plasma density decay coupled with retarding potential ion

energy measurements show that in ≥5 kG minimum-B confinement fields, the contained plasma decays with a lifetime limited only by Coulomb scattering into the containment field mirror loss cones. This report describes the results of the investigation carried out under the subject contract for the current contract period and Appendix I is a report on the Third EURATOM Study Group Conference on Laser-Produced Plasmas attended by A. F. Haught. (auth)

14811 ON THE PARAMETERS WHICH CONTROL THE FORWARD VELOCITY OF A BOSTICK PLASMOID. Butter, D. A. (General Electric Co., Cleveland). Phys. Lett., 28A: 411-12 (Dec. 30, 1968).

The forward velocity of Bostick plasmoids is shown experimentally to be proportional to the mean surge current through their button source. (auth)

14812 GAS BREAKDOWN WITH NANOSECOND PULSES. Bobin, J. L.; Canto, C.; Floux, F.; Guyot, D.; Reuss, J.; Veyrie, P. (CEA, Villeneuve-Saint-Georges, France). IEEE (Inst. Elec. Electron. Eng.), J. Quant. Electron., QE-4: 923-31(Nov. 1968).

Preliminary results obtained by focusing the Oscar-rewarded C.G.E. laser in air and deuterium of moderate pressure are presented. A fast plasma expansion is identified as a breakdown wave. The influence of the initial pressure on propagation speed and light absorption was studied. Breakdown waves were also found in light–matter interaction in high-pressure gas (30-ns laser pulses) and in solid-state dielectrics (short pulses). A theoretical approach is outlined that would permit the achievement of high temperatures, despite the presence of breakdown waves. (auth)

14813 STUDY OF HEAT REMOVAL INTO A CATHODE SPOT OF A QUICK-FLOW ELECTRIC ARC. Shaboltas, A. S.; Borovchenko, E. A. (Minsk Inst. of Heat and Mass Exchange). Inzh.-Fiz. Zh., 15: 1009-13(Dec. 1968). (In Russian).

Installation and methods are described for the study of heat transfer in the near-electrode regions of high-flow blown electric arc of a coaxial sectional plasma generator. Experimental data are presented which show the dependence of heat removal through the cathode spot on the current intensity at air expense 6.6 g/sec and intensity of an external magnetic field 850 e. (auth)

14814 PINCH SOURCE OF IONIZED CLOTS FOR AEROPHYSICAL INVESTIGATIONS AT HIGH PRESSURES. Balyberdin, V. V.; Gurpv, V. M.; Papkovich, V. G. pp 77-81 of Samoletostr. i Tekhn. Vozd. Flota. Resp. Mezhved. Nauchno-Tekhn. Sb. Part V. 1966. (In Russian).

A description is given of the creation of a source of plasma clots of diameter 3 to 4 cm, issuing with a velocity of 400 to 500 m/sec. The electrical discharge of the condenser battery of capacity 12 mf (the discharge current was measured by a Rogowski loop and was found to be equal to 7 kA) proceeds through two electrodes, one of which is at the same time the nozzle of the source. The plasma clots thus obtained were investigated with the aid of a photomultiplier and high-speed cinephotography. The presence of considerable inhomogeneities in the flow is established. By means of a ballistic pendulum, the momentum of the gas and the discharge of the material of the gas emitter were investigated. The results of measurements made for different intensities of the source and for different lengths of the discharge gap, which are presented graphically, testify to the fact that with increase of the length of the discharge gap, the momentum of the gas increases. On the basis of the observations which were made, the conclusion is drawn that the efficiency of the source lies in the region of 1 to 2%. (auth) (App. Mech. Rev.)

Stability

14815 ON SHEAR INSTABILITY IN COLD PLASMAS WITH EXTERNAL MAGNETIC FIELD. Gratton, F.; Gratton, J. (Univ., Buenos Aires). Nucl. Fusion, 8: 269-72(Oct. 1968).

An unbounded collisionless cold plasma with external uniform magnetic field is considered. Equations showing the shear instabilities are derived. (M.O.W.)

14816 FLUTE INSTABILITY OF A CURRENT-CARRYING CURVED PLASMA COLUMN. Shafranov, V. D. (Inst. of Atomic Energy, Moscow). Nucl. Fusion, 8: 253-62(Oct. 1968).

Suydam's criterion for an arbitrarily curved plasma column is generalized. Mercier's well-known results concerning the local stability of a plasma in the vicinity of the magnetic axis are a special case arising from this criterion. In a curved plasma column, in addition to the stabilizing effect of shear, the stabilizing role of the "magnetic well" assumes importance. The magnetic well is produced by a displacement of the magnetic axis into the region where the toroidal magnetic field is weaker. The contribution to the magnetic well made by that part of the displacement which is associated with ballooning of the plasma column as a whole exactly cancels the ballooning mode. The part of the displacement due to electrodynamic stretching of the current column creates a "vacuum" magnetic well that is independent of plasma pressure. In stability criterion given in this paper the stabilizing role of the vacuum magnetic well manifests itself in the coefficient F, which is dependent both on the mean curvature of the plasma column and on its harmonics. The condition for stabilization by the magnetic well, $F > 1$, imposes a limitation on the "stability safety factor" $q = 2\pi r B_z(r)/LB_\theta$. The author considers regions where there are variations in the values q ensuring stability for systems of the racetrack and spatial figure-eight types. (auth)

14817 MEASUREMENTS OF GROWTH AND DAMPING RATE OF RESISTIVE INSTABILITY IN GASEOUS PLASMA. Saito, Susumu; Hatta, Yoshisuke (Tohoku Univ., Sendai). J. Phys. Soc. Jap., 26: 175-81(Jan. 1969).

Time rates of growing and damping of resistive instability in gaseous plasma in the crossed electric and magnetic fields are obtained experimentally. The discharge tube used has a coaxial cylindrical configuration with a grid and works in the state of "anode glow mode." The gas used is Ne, Ar, and Hg. The damping rate is measured by means of an external excitation of damping waves by supplying a rectangular pulse to the grid. The growth rate is obtained by an observation of the transient of self-excitation of waves by abrupt change of the magnetic field strength beyond the critical field. Those experimental results are compared with those obtained theoretically using equations of three component fluid model. (auth)

14818 PIG DISCHARGES IN VARIOUS FIELD CONFIGURATIONS. Kuroda, Tsutomu; Horikoshi, Gen'ichi; Nagao, Shigeo (Nagoya Univ., Japan). J. Phys. Soc. Jap., 26: 181-7(Jan. 1969).

PIG discharges with uniform magnetic field configuration and diverter-type field configuration are studied. Low-frequency fluctuations in the plasma column are observed by a Langmuir probe and two phototransistors. In the case of uniform field configuration, the frequencies of fluctuation agree well with the theory by Hoh and Simon. In the case of diverter-type field configuration, the amplitude of fluctuation is small compared with that for uniform-field configuration. Plasma parameters (space potential, particle density, and electron temperature) are measured for both magnetic field configurations. The most remarkable difference between two types of field configurations exists in radial electric field intensity. In a uniform configuration, the radial electric field E_r is about 3 to 4 V/cm, whereas in a diverter-type field configuration, E_r is only 0.2 V/cm or less. This small E_r results in a rather quiescent PIG discharge in a diverter-type field configuration. (auth)

14819 THE ION CYCLOTRON DRIFT LOSS-CONE INSTABILITY IN MIRROR MAGNETIC WELLS. Cordey, J. G.; Kuo-Petravic, L. G.; Petravic, M. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Nucl. Fusion, 8: 153-9(Oct. 1968).

The ion cyclotron drift loss-cone instability was studied for the case of steep particle density gradients $[(1/n)(dn/dr)a_i \simeq -0.3]$, magnetic field gradients and finite plasma dimensions. Computational results show that there are no high-density stable regimes. It was found that for a mirror velocity distribution the magnetic well field gradient is de-stabilizing, in contrast to the stabilizing effect found by Krall and Fowler for a near-Maxwellian velocity distribution. Potential distributions and critical densities were found for a slab model using appropriate boundary conditions to determine the modes. The threshold densities for the boundary value case are only slightly higher than that given by the usual local approximation. Frequencies and growth rates as functions of azimuthal wave number are found for the instability for typical PHOENIX II and ALICE parameters. (auth)

14820 A STUDY OF PLASMA STABILITY IN SHEARED MAGNETIC FIELDS. Davidson, James N.; Kammash, Terry (Univ. of California, Livermore). Nucl. Fusion, 8: 203-40 (Oct. 1968).

In this review paper the basic equations for the study of the stability of inhomogeneous plasma in sheared magnetic fields are derived and examined for normal mode and wave-packet perturbations. Special emphasis is placed on the detailed mathematical formalisms usually employed in the analysis of such problems, and numerous known examples are used as applications. (auth)

14821 INSTABILITY OF TRANSVERSE WAVES IN A RELATIVISTIC PLASMA. Lerche, I. (Univ. of Chicago). J. Math. Phys. (N.Y.), 10: 13-20(Jan. 1969).

Linearized equations are set up to describe disturbances in an infinite, spatially uniform, relativistic plasma without an ambient magnetic field. It is shown that, as well as the usual electrostatic waves, there also exists a class of electromagnetic waves. The two sets of waves are coupled in general, but can still be classified as mainly longitudinal or mainly transverse. Under the assumption that the system is stable against the longitudinal disturbances it is shown that the relativistic plasma will be unstable to the transverse waves unless it is virtually isotropic. (auth)

14822 DECAY OF A LANGMUIR WAVE. RESONANCE AND PARAMETRIC AMPLIFICATION CONDITIONS. Perulli, Mariano; Laval, Guy; Pellat, Rene (EURATOM-CEA, Fontenay-aux-Roses, France). Compt. Rend., Ser. A and B, 267: 1070-3(Nov. 13, 1968). (In French).

A Langmuir wave of frequency f_1, excited in a plasma column with the aid of an antenna, is disintegrated when its amplitude is sufficiently high. The disintegration spectrum is produced in a band of frequencies always below f_1 and is interpreted, beginning with a nonlinear interaction mechanism between three Langmuir waves. This interpretation is confirmed by the measurement of the spatial structure of the different modes as well as by the parametric amplification of a wave excited to one of the frequencies of the disintegration spectrum. (tr-auth)

14823 ONSET OF THE HELICAL INSTABILITY IN WEAKLY IONIZED DISCHARGE PLASMAS. Robertson, Harry S.; Currie, Edward H. (Univ. of Miami, Coral Gables, Fla.). Phys. Fluids, 12: 200-2(Jan. 1969).

The helical instability in a discharge plasma has been variously reported, sometimes as having an explosive onset, sometimes as reversible. Experiments in cesium arc plasmas show that the onset is always explosive provided the ambient noise level is low enough; hysteresis is normally present; and plasma parameters change discontinuously at the onset and extinguishment of the instability. In the presence of noise, however, the onset is reversible and continuous. (auth)

14824 DRIFT INSTABILITIES IN A UNIFORMLY ROTATING PLASMA CYLINDER. Chu, T. K.; Coppi, B.; Hendel, H. W.; Perkins, F. W. (Princeton Univ., N. J.). Phys. Fluids, 12: 203-8(Jan. 1969).

The dispersion relation for low-frequency, collisional, electrostatic waves in a uniformly rotating plasma cylinder is obtained in terms of several positive-definite bilinear forms whose magnitude may easily be estimated. The effects of ion transverse collisional viscosity, electron parallel resistivity, ion parallel motion, and an equilibrium radial electric field are included in the theory. The close correspondence between the present dispersion relation and the dispersion relation for localized, slab-model modes justifies the use of the latter in the interpretation of Q-machine experiments. Another result is that ion collisional viscosity stabilizes the density-gradient driven drift wave if the axial wavelength $\lambda_\parallel$ satisfies $\lambda_\parallel < 2\pi\sigma r_0 (M/m_e)^{\frac{1}{2}}$, ($\sigma \sim 0.7$; r_0 is the density gradient scale length; M, m_e are the ion and electron masses, respectively). Overstable waves, which are driven by the centrifugal force and which resemble flutes with a finite parallel wavelength, can exist if $\lambda_\parallel$ is sufficiently long. (auth)

14825 POSSIBLE CAUSE OF PLASMA TURBULENCE IN A HIGH CURRENT TOROIDAL DISCHARGE. Larionov, M. M; Rozhdestvenskii, V. V. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekh. Fiz., 38: 391-4(Feb. 1968). (In Russian).

This is a generalization and an investigation of the results of earlier work (Zh. Tekh. Fiz., 36: 1843(1964) and elsewhere) on plasma diagnostics by microwave noise measurements and charge-particle energy measurements. The experimental data are used to calculate the dependence of the ratio of the maximum gas-kinetic pressure of the plasma to the magnetic pressure on the discharge axis as a function of a parameter characterizing the distribution of the fields and the currents in the discharge. The values of the maximum pressure of a plasma that is stable to convective perturbations in accordance with Suydam's criterion are calculated from data on the stabilizing magnetic field and the discharge current and on the basis of the equation for the largest pressure of the plasma in a discharge with a force-free field configuration. Satisfactory agreement between the actually existing pressure in the plasma and the calculated pressure is noted. The largest plasma pressure in the discharge exceeds the pressure at which it becomes possible for convective instability to develop by not more than 2 to 3 times. The results confirm the assumption that under the investigated discharge conditions the turbulence phenomena in the plasma are due to development of convective instability, and that this type of instability limits further increase of the plasma temperature. (ATD)

14826 PERIODIC PULLING AND TURBULENCE IN A BOUNDED PLASMA. Abrams, R. H. Jr.; Yadlowsky, E. J.; Lashinsky, H. (Univ. of Maryland, College Park). Phys. Rev. Lett., 22: 275-8(Feb. 17, 1969).

Experimental results obtained with a Q machine demonstate the effect of a nonlinear mechanism called periodic pulling that has been proposed to explain the transition to turbulence in a bounded plasma characterized by weakly unstable modes. The effect is characteristic of any distributed-parameter system that can be described by the van der Pol equation and is related to phenomena observed in solid-state oscillators and the gas laser. (auth)

14827 THEORY OF STABILITY OF A WEAKLY IONIZED PLASMA IN EXTERNAL ELECTRIC FIELD. Milich, B.; Rukhadze, A. A. (Lebedev Inst. of Physics, Moscow). Zh. Tekh. Fiz., 38: 229-39(Feb. 1968). (In Russian).

This is a continuation of earlier work (Zh. Eksp. Teoret. Fiz., 48: 1656(1965)) and is devoted to an investigation of the stability of a weakly ionized plasma in an external electric field with the aid of kinetic equations with a model collision integral. It is assumed that particles of one type acquire as a result of collisions with the particles of another type a local-equilibrium Maxwellian distribution, characterized by a certain effective temperature which is defined as the product of the reduced mass of the colliding particles and the sum of the squares of their thermal velocities. The calculations were performed under the assumption that during the course of the collision the temperatures of the charged particles remain constant, the neutral particles are not disturbed, and their drift is equal to zero. The equilibrium electron distribution function is calculated by expansion in terms of a small parameter representing the ratio of the drift velocity to the thermal velocity of the electrons. Terms quadratic in this ratio were retained in order to ensure the analogy with the results of the theory that does not take into account the particle collisions. A perturbation method was used to calculate the dielectric tensor of a weakly ionized plasma in an external electric field. The spectra of the longitudinal and transverse plasma oscillations in the external field are investigated. In the hydrodynamic limit, the dispersion equation obtained in the present paper coincides with the results of the earlier paper. (ATD)

14828 INFLUENCE OF FINITE LARMOR RADIUS AND FINITE CONDUCTIVITY ON THE GRAVITATIONAL INSTABILITY OF A PLASMA. Bhatia, P. K. (Univ. of Jodhpur, India). Nuovo Cim., 59B: 228-35(Feb. 11, 1969).

The influence of finite Larmor radius (F.L.R.) on the gravitational instability of a finitely conducting rotating plasma was studied. The effect of Hall current was also included. It is found that Jeans' criterion remains unchanged in the presence of F.L.R. rotation, finite conductivity, and Hall current effects. (auth)

Thermonuclear Processes

Refer also to abstract 14438.

14829 EXPERIMENTS ON THE OBSERVATION OF NEUTRON EMISSION AT A FOCUS OF HIGH-POWER LASER RADIATION ON A LITHIUM DEUTERIDE SURFACE. Basov, N. G.; Kriukov, P. G.; Zakharov, S. D.; Senatskii, Yu. V.; Tchekalin, S. V. (Lebedev Physical Inst., Moscow). IEEE (Inst. Elec. Electron. Eng.), J. Quant. Electron., QE-4: 864-7(Nov. 1968).

Theoretical calculations indicate that laser radiation may be used to heat a deuterium plasma to temperatures at which thermonuclear neutron emission may be observed. Using a neodymium glass laser, producing a 20-joule pulse of approximately 10^{-11}-second pulse length, preliminary evidence of neutron emission has been obtained. (auth)

Wave Phenomena

14830 (AEC-tr-7017) INTERACTION BETWEEN ION FLUX AND TARGET PLASMA DURING CHARGE EXCHANGE. Kartashev, K. B.; Pistunovich, V. I.; Filimonova, E. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Atomnoi Energii). Translation of report IAE-1400. 24p. Dep. CFSTI.

An abstract for the original report appeared earlier in NSA 22: 19961. (M.O.W.)

14831 PARAMETRIC EXCITATIONS IN PLASMA IN A MAGNETIC FIELD. Tzoar, N. (City Univ., New York). Phys. Rev., 178: 356-62(Feb. 5, 1969).

The coupled Vlasov equations for electrons and ions in the presence of a strong long-wave-length electromagnetic field

are solved. Calculations of the growth rates for the excitation of the upper-hybrid, lower-hybrid, and the Bernstein modes are presented and discussed. (auth)

14832 SCATTERING OF ELECTROMAGNETIC WAVES BY THE TURBULENT PULSATIONS IN AN INHOMOGENEOUS MAGNETOACTIVE PLASMA. Sakhokiya, D. M.; Tsytovich, V. N. (Tbilisi State Univ., USSR). Nucl. Fusion, 8: 241-51(Oct. 1968).

The theory of high-frequency electromagnetic wave scattering by the turbulent pulsations in a plasma contained by an external magnetic field is discussed. The effects accompanying the scattering of waves in both inhomogeneous and homogeneous magnetoactive plasmas are discussed. The effects of quasi-elastic and diffusion scattering are also analyzed. The possibilities of using calculated scattering effects for diagnosing the turbulent state of a plasma are discussed. (auth)

14833 NONLINEAR OSCILLATIONS IN A COLD PLASMA. Davidson, R. W. C.; Schram, P. P. J. M. (Univ. of California, Berkeley). Nucl. Fusion, 8: 183-95(Oct. 1968).

In a Maxwell-fluid description large-amplitude electrostatic and electromagnetic oscillations in a cold plasma are analyzed in situations where the spatial variations are one-dimensional and the ions form a fixed neutralizing background. In the electrostatic approximation a Lagrangian description following the electron motion is adopted, and exact solutions obtained in these variables in situations where multistream flow does not develop. The inversion to Eulerian coordinates is carried out explicitly for the particular example of an initial sinusoidal perturbation in density. A model describing the dispersive modifications of (weak) thermal effects is analyzed showing the phase mixing of (moderately) large-amplitude initial disturbances. After sufficient time, the electron fluid becomes stationary and a low level of electric field remains balancing the force due to pressure variations. In addition, for the case of nonlinear electrostatic oscillations perpendicular to a static magnetic field, the exact solution in Lagrangian variables shows that, for a cold plasma, coherent oscillations at the upper hybrid frequency are maintained indefinitely over the regions of initial excitation. Electromagnetic oscillations are considered as developing from small initial values on the background of the large-amplitude longitudinal oscillations already calculated. The resulting wave equation is analyzed for several limiting cases. It is shown that for sufficiently short wavelengths of the transverse fields there exists an infinite number of narrow ranges of the wave number in which the transverse oscillations are unstable. The growth is ultimately limited by the magnetic force which was neglected in the description of the longitudinal motion. Finally, stationary solutions are studied. In the electrostatic approximation, a very special class of periodic Bernstein–Greene–Kruskal waves without trapped particles is obtained. Again, the electromagnetic solutions are unstable (in space), the growth being limited by the same effect as in the time-dependent problem. A simple class of special stationary solutions is obtained for the complete problem including all magnetic force terms. (auth)

14834 GENERAL DISPERSION RELATIONS FOR LINEAR WAVES IN MULTICOMPONENT PLASMAS. Verheest, F. G. (Rijksuniversiteit, Ghent). Physica, 34: 17-35(1967).

The usual linearization technique for the treatment of plane waves propagating through an infinite and homogeneous plasma is applied to the equations of motion, describing a plasma consisting of N different species of particles. The dispersion formula thus obtained is discussed at length for some special positions of the external magnetic field (zero, parallel and perpendicular to the wave vector). It is shown how the number N of components of the plasma has no qualitative influence on the transverse electromagnetic waves. The possible number of longitudinal plasma waves, however, is increased. A comparison between a one-, a two- and a multi-component description of a plasma is made, and a preference for a multi-component theory is indicated. Some attention is given to the time damping of the waves as a result of collisions. (auth)

14835 DISPERSION RELATIONS FOR LINEAR THREE-COMPONENT PLASMAS. Verheest, F. G. (Rijksuniversiteit, Ghent). Physica, 34: 36-41(1967).

The previously derived dispersion relations are applied to a partially ionized three-component plasma. Two extreme degrees of ionization are considered, and dispersion formulas are obtained both in the absence of an external magnetic field and in the presence of such a field parallel to the wave vector. In addition to several known results some new formulas have been put forward, especially for a weakly ionized plasma. (auth)

14836 LINEAR WAVES IN WEAKLY IONIZED MULTICOMPONENT PLASMAS. Verheest, F. G. (Rijksuniversiteit, Ghent). Physica, 34: 42-6(1967).

The dispersion relations developed in a previous paper are used to investigate weakly ionized plasma, consisting of N different species of ions (being indifferently positively or negatively charged) and N′ kinds of neutral particles. An external magnetic field parallel to the wave vector is applied. These assumptions allow the recasting of the dispersion equations into short formulas, yielding resonance frequencies. (auth)

14837 PARAMETRIC COUPLING BETWEEN TRANSVERSE ELECTROMAGNETIC AND LONGITUDINAL ELECTRON WAVES. Sjoelund, A.; Stenflo, L. (Royal Inst. of Tech., Stockholm). Physica, 35: 499-505(1967).

Parametric coupling between electron plasma waves and transverse electromagnetic waves in a hot electron plasma is studied by means of coupled-mode theory. The coupling coefficients are determined. Two instructive examples of parametric coupling are considered. The growth rate of the amplitudes of the excited waves is calculated and some numerical results are given. (auth)

14838 NATURE OF THE ROTATIONAL DISCONTINUITY. Gerdin, G. A.; Sonnerup, B. U. O. (Dartmouth Coll., Hanover, N. H.). Phys. Fluids, 12: 145-8(Jan. 1969).

The behavior of a large-amplitude intermediate magnetohydrodynamic wave in the presence of reflected particles is examined. For reflections off its front side, the wave becomes a spreading expansion wave; for reflections off the back side it steepens to a shock wave, i.e., an entropy increase is produced across the wave. (auth)

14839 GENERAL WEAK TURBULENCE THEORY OF RESONANT FOUR-WAVE PROCESSES. Davidson, Ronald C. (Univ. of California, Berkeley). Phys. Fluids, 12: 149-61(Jan. 1969).

The time evolution of wave correlations (cumulants) in a uniformly turbulent ensemble of weakly nonlinear, dispersive systems is discussed. With closure of the hierarchy for wave correlations appropriate to the inclusion of resonant four-wave processes, a kinetic equation for the spectral energy density of the waves is derived in situations where the resonant three-wave decay condition cannot be satisfied. The resulting kinetic equation is a nonlinear integrodifferential equation with driving terms trilinear in the energy density. Some general properties of this equation are discussed, including associated conservation relations and the law of increase of entropy. (auth)

14840 ELECTROSTATIC PLASMA OSCILLATIONS IN AN ALTERNATING EXTERNAL ELECTRIC FIELD. Rebhan, Eckhard (New York Univ., N. Y.). Phys. Fluids, 12: 192-200(Jan. 1969).

The one-dimensional electrostatic oscillations of a plasma are investigated under the influence of an alternating external electric field. If the motion of ions is ignored, it is shown that there is no influence of the external field on the stability of the plasma, even nonlinearly. The motion of the ions is taken into account by an expansion with respect to the mass ratio $\alpha = m_-/m_+$. A dispersion relation for linear plasma oscillations is derived and investigated for different limiting cases. The influence of the external field is shown to be destabilizing on the electron–electron two-stream instability for all frequencies and amplitudes. (auth)

14841 PLASMA FLUCTUATIONS AND CONVECTIVE MODES. Kent, A.; Taylor, J. B. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Phys. Fluids, 12: 209-12(Jan. 1969).

The electric field fluctuations in an inhomogeneous plasma are calculated directly, using a test-particle method, and the result interpreted in terms of convective modes. This serves to place the usual convective mode picture on a more secure basis. (auth)

14842 DISPERSION OF THE UPPER HYBRID MODE IN A SPATIALLY INHOMOGENEOUS PLASMA. Pearlstein, L. D.; Bhadra, D. (Gulf General Atomic Inc., San Diego, Calif.). Phys. Fluids, 12: 213-19(Jan. 1969).

The dispersion of the normal mode at the upper hybrid frequency propagating parallel to a uniform magnetic field in a spatially inhomogeneous plasma is calculated. For the case where the density varies in a direction perpendicular to the magnetic field, it becomes necessary to solve a fourth-order differential equation for the perturbed potential. The method of solution is a WKB analysis of this equation. A Maxwellian plasma and a Maxwellian plasma with a superimposed beam parallel to the magnetic field are considered. Finally, the relevant dispersion relations are solved using a digital machine, and comparison is made with results of a recent experiment. (auth)

14843 VARIATIONAL STUDY OF PLASMA OSCILLATIONS WITH DIFFUSION IN VELOCITY SPACE. Babloyantz, Agnessa (Univ. Libre, Brussels). Phys. Fluids, 12: 262-4(Jan. 1969).

It is shown that the local potential method can be applied for the study of plasma oscillations in the presence of linear and nonlinear collision operators. (auth)

14844 EXPERIMENTAL OBSERVATION OF LOW-FREQUENCY OSCILLATIONS DESCRIBED BY THE PLASMA CONTINUITY EQUATIONS. Roth, J. Reece (Lewis Research Center, Cleveland). Phys. Fluids, 12: 260-2(Jan. 1969).

Low-frequency oscillations in the electron number density of a slightly ionized gas have been experimentally observed over the range 10^2 to 10^5 Hz, and identified with periodic solutions to the neutral and charged-particle continuity equations. (auth)

14845 EXCITATION OF ION-CYCLOTRON OSCILLATION IN PLASMA IN EXTERNAL ELECTRIC FIELD. Milich, B.; Zyunder, D. (Lebedev Inst. of Physics, Moscow). Zh. Tekh. Fiz., 38: 220-8(Feb. 1968). (In Russian).

The critical drift of electrons in a fully ionized plasma situated in an external constant electric field of sufficient strength to build up ion cyclotron oscillations is discussed. The problem is considered within the framework of kinetic theory, and the collisions between the charged particles are taken into account by means of the exact Landau collision integral. In considering the dispersion equation for the potential oscillations of the plasma, expressions are derived for the dielectric constant of the plasma at frequencies of cyclotron resonance, and with allowance for the ion and electron collisions. The method of finding the critical drift is described. Conditions are considered for the excitation of ion cyclotron waves in a plasma with collisionless electrons and with electrons subject to strong collisions. It is noted that in a weakly nonisothermal plasma the collisions of the electrons can play a very important role in the buildup of the cyclotron waves, provided their effective collision frequency is larger than the cyclotron frequency of the ions. Ion collisions are in this case relatively unimportant, and the principal role is played by Cherenkov damping on ions. Conditions are presented under which the particular dissipation mechanism becomes decisive for the buildup of cyclotron waves. Expressions are presented for the minimum drift velocity corresponding to the start of the instability. (ATD)

14846 INSTABILITY OF NONPOTENTIAL OSCILLATIONS OF A WEAKLY IONIZED PLASMA WITH CURRENT. Gruzdeva, V. F.; Triger, S. A. (Moscow Power Inst.). Zh. Tekh. Fiz., 38: 462-4(Mar. 1968). (In Russian).

This is a continuation of earlier work and is devoted to a weakly ionized plasma with a current flowing perpendicular to the external magnetic field. Losses connected with the finite conductivity and with the nonvanishing viscosity and thermal conductivity are neglected in the case of a homogeneous plasma, and the wavelength of the oscillations in question is assumed much larger than the particle mean free path. The system of equations for such a plasma is derived from the equations of three-liquid magnetohydrodynamics and is linearized relative to small deviations from equilibrium. This results in dispersion equations for the oscillations with wave vector perpendicular to the magnetic field. An analysis of these equations shows that allowance for the nonpotential oscillations in such a configuration leads to buildup of a fast magnetosonic wave with the current velocity of the electrons exceeding the phase velocity of the wave, and also to the occurrence of instability of current waves. The current waves build up both in the direction of the current and in the opposite direction, thus broadening the spatial region of the instability. The damped and the growing current waves have different polarizations. (ATD)

14847 NEGATIVE GROUP VELOCITY IN MAGNETOACTIVE MEDIUM. Kurdyumov, V. N. (Radiotechnical Inst., Moscow). Zh. Tekh. Fiz., 38: 260-3(Feb. 1968). (In Russian).

The purpose of this paper is to correct an error in an earlier paper (Zh. Tekh. Fiz., 35: 1771(1965)), where the wrong sign was given for the imaginary part of the poles in a magnetoactive medium, and also to classify the types of refractive-index surfaces in a magnetoactive medium without spatial dispersion. For the simplest magnetoactive medium, without allowance for spatial dispersion, the dielectric tensor components, being functions of the frequency only, are not connected with one another by any conditions and can assume either positive or negative values. The type of the surface representing the wave vectors depends on the relations between these quantities. In the investigation of the sign of the group velocity it is possible to separate ten different variants of the form of the surfaces of the wave vectors. These variants are illustrated by a table and a figure, in which are shown the quadrants of the sections of the wave-vector surfaces by the plane passing through the optical axis. The group velocity was assumed negative if the sign of its projection on the radius did not coincide with the sign of the projection of the wave vector. From an analysis of the plots it is concluded that the imaginary addition to the square of the wave vector reverses sign on going from the region with negative group velocity to the region with positive group velocity. Certain expressions of the earlier paper are corrected on the basis of the correct choice of the sign of the imaginary additions. (ATD)

14848 OSCILLATIONS OF A PERIODIC ION-ACOUSTIC WAVE. Petviashvilli, V. I. Zh. Tekh. Fiz., 38: 205-12(Feb. 1968). (In Russian).

An investigation was made of ion-acoustic oscillations of finite amplitude in a plasma with cold ions. The periodic ion-acoustic wave is assumed to consist of uniformly spaced solitons—bunches of positive charges of width on the order of the Debye radius of the electrons, propagating with a velocity on the order of that of ion sound. The profile of the wave is assumed to be stationary in a reference frame moving at the same phase velocity as the ion-acoustic wave. Expressions are obtained for the hydrodynamic velocity and the density of the particles in such a wave in terms of a periodic function of the wave propagation coordinates (this function is determined in the paper), the phase velocity, and the amplitudes of the solitons. The properties of an infinitesimally small long-wave perturbation in the indicated plasma are investigated. In the presence of perturbation, the velocity and the density of the particles in the plasma with periodic ion-acoustic wave are not strictly periodic functions, but they can be expressed in terms of the indicated periodic function by using the Van-der-Pol method. By averaging the plasma equation over the fast oscillations of the periodic wave, a quadratic dispersion equation is obtained relative to the phase velocity of the soliton sound. In the small-amplitude limit, one of the roots of this equation coincides with the group velocity of the linear ion-acoustic wave. If the wave amplitude exceeds a certain critical value, which is calculated in the paper, the roots of the dispersion equation of the soliton sound become complex, thus indicating that such an ion-acoustic wave is unstable. It is noted that the instability sets in as a result of the change of the repulsion between the solitons with increasing amplitude into attraction. At relatively small wavelengths, the ion-acoustic wave becomes unstable long before the start of the capture of the ions in the potential wells between the solitons. This hydrodynamic buildup of soliton sound can lead to the occurrence of strong turbulence in the plasma. (ATD)

14849 INTERACTION OF PLANE ELECTROMAGNETIC WAVES WITH A MOVING COMPRESSIBLE PLASMA FLUID. Fujioka, H.; Nihei, F.; Kumagai, N. (Osaka Univ.). Can. J. Phys., 47: 375-87(Feb. 15, 1969).

The problem of reflection and transmission of plane electromagnetic waves by a semi-infinite compressible plasma fluid moving parallel to its own interface with vacuum is investigated. Solutions are obtained for both incident E wave and H wave. It is found that (i) for the case of incident E wave which excites only two distinct magnetoacoustic waves, the reflection and transmission coefficients add to unity; however, (ii) for the incident H wave which excites only the transverse magnetohydrodynamic wave, both coefficients do not add to unity in general, because of the interaction of the electric field of the transmitted wave with surface charge density at the moving interface. Other interesting features due to the movement of the medium are discussed, and a few numerical examples are given. (auth) (Canada)

14850 INDUCED SCATTERING OF QUASI-LONGITUDINAL WAVES IN MAGNETOACTIVE PLASMA. I. Kropotkin, A. P.; Pustovalov, V. V.; Sholokhov, N. V. (Lebedev Inst. of Physics, Moscow). Zh. Tekh. Fiz., 38: 240-9(Feb. 1968). (In Russian).

This is a continuation of earlier work by the authors (Zh. Eksp. Teoret. Fiz., 49: 1345(1965)) and is devoted to nonlinear interactions of quasi-longitudinal waves via a virtual longitudinal wave. The external magnetic field was assumed to be sufficiently strong so that the Larmor radii of the electrons were small compared with the wavelength of the interacting oscillations, and the oscillation frequencies were much smaller than the ion gyro frequency. Under such conditions, there can exist in the plasma, at suitable ratios of the temperatures, quasi-longitudinal oscillation of three different spectra: ion sound, electron sound, and low-frequency long-wave oscillations of the cold plasma. The frequency in the wave vector were assumed to be equal to the difference of the frequencies and the wave vectors of the interacting oscillations. Equations are obtained describing the nonlinear interactions for all low-frequency longitudinal waves. From the obtained kernels of these equations it is possible to determine directly the differential scattering cross sections in the processes in equation. Comparison of the results with the formulas for the scattering of longitudinal waves in an isotropic plasma shows that analogy exists between the wave scattering processes in a magnetoactive plasma and the scattering of electron Langmuir waves in an isotropic plasma. This analogy with the isotropic plasma is explained by the fact that in the case of a strong magnetic field

particle oscillations are possible only in that direction of this field in which they occur in an isotropic plasma. (ATD)

14851 DIFFRACTION OF CYLINDRICAL WAVES ON A HALF-PLANE IN ANISOTROPIC PLASMA. Fisanov, V. V. (Siberian Physical-Technical Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 10, 70-5(1968). (In Russian).

The problem of diffraction of cylindrical waves on a half-plane in cold anisotropic plasma is considered. It is shown that a valid solution can be represented in the form of Fresnel integrals. (tr-auth)

14852 SURFACE AND BULK WAVES ON AXIALLY MAGNETIZED PLASMA COLUMNS. Bevc, Vladislav (Aerospace Corp., Los Angeles). J. Appl. Phys., 40: 633-40(Feb. 1969).

The dispersion relation and field solutions of slow electromagnetic waves propagating along a cold, collisionless, cylindrical plasma in an axial magnetic field of finite magnitude are studied numerically. Field distribution and gradual metamorphosis of surface waves into bulk waves along the dispersion characteristics are investigated. It is shown that both surface waves and bulk waves belong to the same set of plasma modes. Criteria concerning conditions under which surface waves occur are extended to include transitional situations. Power-flow density along the plasma may in certain cases be in opposite directions inside and outside of the plasma, both for forward surface waves as well as for backward cyclotron waves, implying transfer of energy between propagation media. (auth)

Shielding

Refer also to abstracts 13693 and 15499.

14853 (IKF-20) A UNIVERSAL MONTE CARLO METHOD FOR SOLUTION OF ELECTRON TRANSPORT PROBLEMS. Wittig, Siegmar (Frankfurt Univ. (West Germany). Institut fuer Kernphysik). Dec. 1968. 69p. (In German). Dep.

A Monte Carlo program was written for the calculation of electron paths in matter. Multiple scattering, straggling of energy losses by ionization and excitation, and bremsstrahlung losses are taken into account. Range and path-length distributions are given for perpendicularly incident electrons in the range from 0.25 to 6 MeV for the absorbers polystyrene, graphite, aluminum, silicon, copper, germanium, silver, gold, and lead. (auth)

14854 TRANSPORT SOLUTIONS TO SHIELDING PROBLEMS: SOME RECENT DEVELOPMENTS. Clifford, C. E.; Mynatt, F. R.; Straker, E. A. (Oak Ridge National Lab., Tenn.). Nucl. News, 12: No. 2, 51-6(Feb. 1969).

A brief discussion of the calculational methods presently used in shielding problems is presented. (M.O.W.)

14855 NUCLEAR DATA REQUIREMENTS AND ACQUISITION FOR SHIELDING APPLICATIONS. Beyster, J. R. (Gulf General Atomic, Inc., San Diego, Calif.); Yost, K. J. Nucl. News, 12: No. 2, 36-41(Feb. 1969).

Shielding data requirements are outlined, and the application of nuclear models to the generation of data for shielding calculations is briefly discussed. The status of experimental techniques for obtaining neutron data is also considered. (D.C.W.)

14856 CALCULATION OF HIGHER ORDER PERTURBATIONS IN THE TRANSPORT THEORY OF GAMMA RADIATION. Uchaikin, V. V. (Tomsk Polytechnical Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 10, 86-91(1968). (In Russian).

Higher order perturbation theory applicable to the transport equation for gamma radiation is presented. An analytical expression for the arbitrary order perturbation of a stream with the variation of electron density of the media independent of its geometry is obtained. In the approximation of constant cross sections this expression permits one to find the perturbation, which depends on the change of chemical composition of the plane layer. A numerical example is illustrated. (tr-auth)

14857 A SIMPLE CALCULATION FOR MEAN PROJECTED RANGE OF FAST ELECTRONS. Tabata, Tatsuo (Radiation Center, Osaka, Japan). J. Appl. Phys., 39: 5342-3(Oct. 1968).

It is shown that the mean projected range of electrons experimentally obtained can be related to the mean range L calculated under the continuous slowing-down approximation by a simple semi-empirical equation. (M.H.R.)

14858 STUDY OF THE FORWARD AND BACKSCATTERED COMPONENTS OF THE SECONDARY ELECTRON FLUX IN THE NONEQUILIBRIUM ZONES IN THE VICINITY OF THE PLANE INTERFACES OF TWO DIFFERENT MEDIA EXPOSED TO THE γ RAYS OF ^{60}Co. Bernard, Michel; Martin, Christian; Martin, Paule-Noelle (Faculte des Sciences, Limoges, France. Centre de Cobaltherapie Chenieux, Limoges, France. Compt. Rend., Ser. A and B, 267: 461-4(Aug. 19, 1968). (In French).

In the transition zones, the components of the electron flux can be measured separately with the aid of pn junctions. The results obtained show that their relative variations are effected according to exponential expressions which depend only on the atomic number of the medium where it is placed and not on the adjacent medium which contributes however by its secondary electrons to the magnitudes studied. (tr-auth)

14859 STUDY OF ENERGY AND ANGULAR DISTRIBUTIONS OF ELECTRONS BEHIND BARRIERS OF DIFFERENT THICKNESS. Kononov, B. A.; Gusev, E. A. (Tomsk Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., No. 10, 147-9(1968). (In Russian).

The space–energy distribution of a monoenergetic electron beam (5.89 and 2.91 MeV), which was sent through a thin target ($t < 2.3$ mg/cm^2) or a thick target ($t = 0.1$ to 0.6 of the electron range), was investigated at angles of 0, 10, 20, and 35° on targets of Be, C, Al, Cu, Sn, Pb, and Bi. Angular distribution functions were also calculated theoretically for Be and Cu, and were compared with the corresponding experimental values. A satisfactory agreement of theory with experiment was noted in the case of copper, but the measured values of the number of scattered electrons exceeded the theoretical values by a factor of two in the case of Be. Spectral distributions of electrons scattered at angles of 0, 10, 20, and 35° in carbon targets having thicknesses of 0.53, 1.25, and 1.78 g/cm^2 are also presented. The most probable energy loss and the form of the spectral distribution are constant at these angles; only the number of scattered electrons varies. When the target thickness attains a value of 0.5 to 0.6 of the electron range, especially for materials with a high atomic number (Z), the angular distribution of scattered electrons varies approximately as $(\cos\theta + 0.717)\cos\theta$. (TTT)

14860 MODELING RELATIONSHIPS FOR RADIATION TRANSPORT WITHIN DUCTS AND OTHER CAVITIES IN SHIELDS. Diaz, Justo; Chilton, A. B. (Univ. of Illinois, Urbana). Nucl. Sci. Eng., 35: 283-5(Feb. 1969).

The fundamental theorems which apply to radiation transport within ducts are pointed out and used as a basis for deciding under what circumstances such model scaling relationships are valid. The theorems are stated for the more general class of shield irregularities, cavities in general. The term "cavity" is used to mean a void space within a shield; and this space may contain material, such as air, only if its radiation interaction is so slight that its effect on the radiation transport is negligible. (M.H.R.)

Solid-State Physics

Refer also to abstracts 14027, 14107, 14369, 14399, 14697, 14701, 15337, 15340, 15755, 15766, and 15767.

14861 (BNWL-SA-2124) COMPUTER SIMULATION OF SHORT TERM ANNEALING OF RADIATION DAMAGE IN α-IRON. Doran, D. G.; Beeler, J. R. Jr. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Oct. 16, 1968. Contract AT(45-1)-1830. 28p. (CONF-681202-1). Dep. CFSTI.

From Meeting of the American Physical Society, San Diego, Calif.

The computer simulation of high energy displacement spikes in neutron irradiated α-iron has been reported by Beeler (Phys. Rev., 150: 470(1966)). His results are strictly applicable only at 0°K. Beeler has developed a computer code to simulate short term annealing at relatively low temperatures at which only interstitials are mobile. This code has been expanded to include vacancy motion so as to apply at higher temperatures. Only short range (5th neighbor or closer) interactions are considered. The activation energies were generalized from the results of Beeler and Johnson (Phys. Rev., 156: 677(1967)) and recent results obtained by the authors—both obtained by computer simulation. The annealing scheme has been applied to three 20-keV displacement spikes. In general, about 80% of the defects are annihilated (in ~10^{-9} sec equivalent real annealing time), there is a net decrease in the number of large vacancy clusters, and most of the surviving interstitials become members of small clusters. (auth)

14862 (INP-571) PROCEEDINGS FROM THE SEMINAR ON SOME ASPECTS OF PRACTICAL APPLICATIONS OF MOESSBAUER EFFECT, KRAKOW, APRIL 1967. (Institute of Nuclear Physics, Krakow (Poland)). 1968. 107p. (In Polish). Dep.

Brief summaries of discussions from 7 papers relating to biological, chemical, and solid-state applications are included in approximately two-thirds of this report. A separate abstract

has been prepared for a more lengthy paper constituting about one-third of the total report. (TSS)

For an abstract of the individual paper see: 14863.

14863 (INP-571, Paper 9) MOESSBAUER EFFECT AND ITS POSSIBLE PRACTICAL APPLICATION. Bara, Jozef (Institute of Nuclear Physics, Krakow (Poland)). 37p. (In Polish).

From Symposium on Radio-Nuclei in Science, Spala, Poland, May 8–10, 1967.

Principles and applications of the Moessbauer effect in chemistry and solid-state physics are briefly reviewed. Decay schemes of ^{57}Co and ^{57}Fe discussed in relation to their uses in Moessbauer effect, and properties of various other nuclides of possible use are tabulated. 28 references. (R.V.J.)

14864 (IS-T-261) DE HAAS–VAN ALPHEN EFFECT AND THE FERMI SURFACE OF THORIUM. Boyle, David Joseph (Ames Lab., Iowa). Nov. 1968. Contract W-7405-eng-82. 111p. Dep. CFSTI.

Thesis.

The de Haas–van Alphen (dHvA) effect has been extensively studied in single crystals of thorium, using the field-modulation technique for magnetic fields of 62 kG and temperature of 1.1°K. The quasi-static fields were precisely determined by means of nuclear magnetic resonance, and the dHvA data were recorded digitally for frequency analysis by the periodogram method. The observed frequencies ranged from 2.0 to 25 MG, with the dominant terms in the 9.5-14 MG band. These results were then compared to the frequency variations arising from the Fermi surface proposed by Gupta and Loucks. The experimental observations of the dominant band were in good qualitative agreement with the electron-surface model of twelve butterfly-shaped pieces along the ⟨1 1 0⟩ directions. The hole surface suggested by the data consists of a quasispherical segment centered at the point Γ of the Brillouin zone, and of dumbbell-shaped pieces with axes along the ⟨1 1 1⟩ directions and centered at the symmetry points L. (auth)

14865 (IS-T-272) ELECTRONIC PROPERTIES AND MAGNETIC ORDERING OF LIGHT RARE-EARTH METALS. Fleming, Gerald Stephen (Ames Lab., Iowa). Nov. 1968. Contract W-7405-eng-82. 72p. Dep. CFSTI.

Thesis.

Energy bands have been calculated for the double hexagonal close-packed rare-earth metals lanthanum, praseodymium and neodymium using the relativistic augmented-plane-wave method. From these bands the densities of states at the Fermi energy and Fermi surfaces were determined. The calculated densities of states are consistently lower than experimentally determined values with the difference being attributable to enhancement due to electron–phonon interactions. These Fermi surfaces all lack the large flat regions perpendicular to the c-axis which are present in all of the hcp rare-earth Fermi surfaces. The absence of this feature appears to indicate that the dhcp structure is energetically more favorable than an hcp structure for these metals. Using the Nd and Pr energy bands the generalized susceptibilities, $\chi(q)$, have been calculated for wave vectors lying in the Γ MLA plane of the Brillouin zone. The susceptibilities are calculated using a constant for the interaction matrix element and also using matrix elements which have a gaussian dependence on the wave vector, q. The susceptibility maximum which apparently determines the magnetic periodicity is due to "nesting" between Fermi surface pieces across the KHLM zone face. This periodicity is in the basal plane and is in good agreement with the basal plane periodicity observed by neutron-diffraction techniques. However, the experimental model has an additional antiferromagnetic ordering between alternate hexagonal layers which is not indicated in the results of the susceptibility calculations. (auth)

14866 (IS-T-281) FREQUENCY DEPENDENCE OF THE MAGNETIZATION OF GADOLINIUM IN THE NEIGHBORHOOD OF THE FERROMAGNETIC ORDERING TEMPERATURE. Olander, Farley (Ames Lab., Iowa). Nov. 1968. Contract W-7405-eng-82. 85p. Dep. CFSTI.

Thesis.

The ac susceptibility of gadolinium was measured as a function of frequency and field from 200 to 295°K. The nature of the $\chi'' - \omega/2\pi - T$ surface for Gd was delineated in the vicinity of the Curie point from 33 to 200 Hz at fields less than 10 Oe. For the two samples in question, if there is a maximum in the losses, then from 232 to 290°K the maximum is found below 20 Hz, while below 232°K the maximum is found above 200 Hz. Measurable losses were found at all experimental frequencies at temperatures below the Curie point, which means that $\chi_0 \neq \chi'$ above 20 Hz. No attempt was made to evaluate β, the damping parameter, because the model relating domain wall motion to the a.c. susceptibility did not fit the experimental results. The lack of agreement between the model and the results is attributed to the lack of linearity of the equations of motion describing the magnetization as a function of time. A thermal hysteresis effect was observed in both components of the ac susceptibility near the Curie point at all experimental frequencies and fields. A field at which both χ' and χ'' are maximum was found to occur between 8 and 25 Oe for Gd-I as the sample was cooled below 232°K. (auth)

14867 MOESSBAUER EFFECT IN Y–Sn ALLOYS. Belyaev, L. M.; Lyubutin, I. S.; Dmitrieva, T. V. (Inst. of Crystallography, Moscow). Fiz. Metal. Metalloved., 25: 187-9(Jan. 1968). (In Russian).

The Moessbauer effect of ^{119}Sn nuclei in Y–Sn alloys with 5, 10, 20, 30, and 95 wt % Sn was measured using a Sn_2O source at room temperature and at liquid nitrogen temperature. According to the constitution diagram, Y–Sn on the Y side forms eutectics with 20% Sn, and at the side of Sn forms a pseudoeutectic close to pure tin. Moessbauer spectra of alloys containing 10, 20, and 30 wt % Sn are identical with alloys containing 95% Y + 5% Sn. The magnitudes of spallation of the central doublets of these alloys, as in 95% Y + 5% Sn alloy, are equal to 0.6 and 3.0 mm/sec, respectively. Isomer shifts are equal to 2.0 mm/sec. (R.V.J.)

14868 EXPERIMENTAL STUDIES OF Mo ENTHALPY AT MAXIMUM TEMPERATURES. Chekhovskoi, V. Ya.; Petrov, V. A. (Inst. of High Temperatures, Moscow). Teplofiz. Vys. Temp., 6: 752-3(July-Aug. 1968). (In Russian).

Enthalpy of Mo specimens with impurities not excluding 0.05 wt % was studied by a mixing method in temperature range from 1000 for 2850°K. Tabulated data calculated by the least-squares method were used to obtain empirical equations for the enthalpy and true specific heat of Mo in the above temperature range. (R.V.J.)

14869 A CONTRIBUTION TO THE INVESTIGATION OF THE SEMICONDUCTIVITY IN EUROPIUM OXIDE EuO. Schwab, Georg-Maria; Bohla, Friedrich (Univ., Munich). Z. Naturforsch., 23a: 1555-8(Oct. 1968). (In German).

By thermal decomposition of a divalent Eu salt or by glowing reduction from the sesquioxide, europium monoxide was prepared. Determinations of the temperature dependence of the conductivity and measurements of the activation energy were made by current–voltage measurements on polycrystalline sintered samples. An attempt was made to give a hole model for the perturbation mechanism occurring. (tr-auth)

14870 EFFECT OF PRESSURE ON THE MAGNETIC RESISTIVITIES AND THE MAGNETIC TRANSITIONS IN Gd–Dy ALLOYS. Yang, Tien-tsai. Los Angeles, Univ. of California, 1968. 96p.

Thesis.

The spin–disorder resistivities and the magnetic phase transitions in the Gd–Dy alloys were experimentally investigated, and the effect of pressure upon the spin–disorder resistivities and the magnetic transitions of Gd–Dy alloys were determined. These were performed by measuring the change of the anomalies in the resistance of samples as a function of temperature and pressure. The resistivities of the metals provide evidence of magnetic transitions, through changes of slope in the resistivity-temperature curves at the critical temperatures. Therefore, the spin-disorder resistivities and the magnetic transitions both under atmospheric and hydrostatic pressures can be obtained from the resistance-temperature curves. The spin–disorder resistivity, ρ_{mag}, of these alloys is equal to $3\pi Nm/2\hbar e^2 E_F\, V^2(g-1)^2 J(J+1)$ where g is the Lande g-factor, J is the total angular momentum quantum number, V is an intra-atomic exchange integral, and E_F is the Fermi energy. The quantity ρ_{mag} was experimentally observed to increase with the increasing Gd composition and pressure. In the Ruder-mann–Kittel theory, the Curie temperature T_c of these alloys is proportional to the quantity $(g-1)^2 J(J+1)\, V^2/E_F\, \Sigma_R\, \Phi(2k_F R)$, where $\Phi(2k_F R) = 2k_F R\cos 2k_F R - \sin 2k_F R/(2k_F R)^4$. The quantity (T_c/ρ_{mag}) was experimentally observed to increase and then decrease as a function of composition with the peak value near 60% Gd–40% Dy, thus indicating that the quantity $\Sigma_R\, \Phi(2k_F R) \propto (T_c/\rho_{mag})$ passes through a similar maximum. T_c for Gd-rich alloys decreased with the application of pressure. T_c for the Dy-rich alloys appeared to increase first, and then to decrease with increasing pressure. The variation of T_c with pressure was explained by the relationship between $\Sigma_R\, \Phi$ and the (c/a) ratio of crystal. It was thus concluded that the quantity $\Sigma_R\, \Phi$ passes through a peak value both as a function of pressure and composition. (Diss. Abstr.)

14871 EFFECT OF THE GAMMA RADIATION INTENSITY ON THE THERMOELECTRIC PROPERTIES OF THE ALLOYS GeTe AND PbSe. Baranova, R. Kh.; Slovokhotov, L. I. pp 53-6

of Preobrazovateli Solnechnoi Energii na Poluprovodnikakh. Moscow, Izdatel'stvo Nauka, 1968. (In Russian).

The experimental results of the investigation of the thermoelectric parameters of the alloys PbSe and GeTe before and after their irradiation with a beam of intense γ radiation were reported. Cast and extruded samples were placed in the direct beam of the synchrotron, working in the regime with maximum energy of the bremsstrahlung E_γ = 260 MeV. The irradiation was carried out continuously for 48 hrs. The activity of the samples was measured by means of a scintillation counter with NaI(Tl) crystal and FEU-13 photomultiplier. It was observed that in the temperature range from 20 to 550°C, the thermoelectric properties of PbSe and GeTe are not altered after irradiation. (tr-auth)

14872 CONVERSION OF F_3^+ CENTERS AND DESTRUCTION OF R CENTERS IN LiF WITH R LIGHT. Vander, Lugt K. L.; Kim, Y. W. (Wayne State Univ., Detroit). Contract AT(11-1)-1054. Phys. Rev., 171: 1096-1103(July 15, 1968).

R_1 and R_2 bleaches of irradiated LiF near 300°K have revealed the existence of a new color center whose main absorption band covers the region of the R_1 and R_2 bands. The new center is not related to any of the known color centers, and facilitates the conversion of F_3^+ centers into R centers according to the mechanism $F_3^+ + e \rightarrow R$, where the electron is provided by the photo-ionization of the new color center by the R bleach. Simultaneously, but at a slower rate, the R bleach also destroys the R centers by two concurrent mechanisms: (a) decomposition of an R center into an M center and an F center, and (b) conversion of an R center into another color center whose absorption band (550 mμ) is in the N-band region. If an N band in LiF is to be identified with the 550-mμ band, the present work favors a rearranged F_3 model for the N center over the current Pick model of an F_4 complex. (auth)

14873 LOW-TEMPERATURE ANNEALING OF NEUTRON- AND GAMMA-INDUCED DEFECTS IN KBr. Hanley, P. R.; Haberl, A. W.; Taylor, A. (Cornell Univ., Ithaca, N. Y.). Solid State Commun., 6: 893-7(Dec. 1968).

Monoenergetic neutrons from $^7Li(p,n)^7Be$ and/or ^{60}Co γ rays were used to produce metastable defects in the form of stored charge in single crystals of KBr at 10°K. Three discrete thermally stimulated conductivity peaks were observed below 40°K. Correlation with optical absorption experiments suggests that the processes responsible for these peaks are controlled by the motion of the Br^- interstitial. (auth) (UK)

14874 ELECTRON-MICROSCOPE INVESTIGATION OF NEUTRON DAMAGE IN SILICON. Pankratz, John Max. Houston, Tex., Rice Univ., 1968. 97p.

Thesis.

Dislocation-free single crystals of three types of silicon were irradiated by 6×10^{17} and 5×10^{19} f.n./cm^3 at 125°C, and eight types of dislocation-free single crystals of silicon were irradiated by 5×10^{18} f.n./cm^3 at 65°C. In addition, some single crystals of silicon containing dislocations and some single crystals of silicon pre-thinned to electron transparency were irradiated under the latter conditions. The irradiated silicon was studied by both bright-field and dark-field transmission electron microscopy. Mean defect image size has been found to depend on the impurity content of the silicon, the irradiation conditions, and the annealing treatment. Mean defect image size ranged from ~22 Å in the most nearly pure silicon in the as-irradiated (5×10^{19} f.n./cm^3 at 125°C) state to a maximum of ~40 Å in the phosphorous-doped Lopex silicon after a 30-min anneal at 700°C. Mean defect image size ranged from ~12 Å in all types of silicon in the as-irradiated (5×10^{18} f.n./cm^3 at 65°C) state to a maximum of ~18 Å in impurity-containing silicon after a 30-min anneal at 600°C. The silicon which received a dosage of 5×10^{19} f.n./cm^3 had a defect density that ranged from ~5×10^{17}/cm^3 in the as-irradiated state to less than 10^{15}/cm^3 after a 1000°C anneal. The defect density is not noticeably affected by the impurities but is approximately proportional to neutron dosage. The properties of the images formed by diffraction contrast in thin silicon specimens have been studied by extending the solutions of the basic equations of the dynamical theory of diffraction contrast with anomalous absorption to defects of the small size encountered in this research. An anomalously wide, black–white image is predicted in dark-field for defects close to a free surface, and the image has a unique sense depending on whether the defect has interstitial or vacancy character. Equations were derived for stereo microscopy, and potential stereo errors were investigated in order to determine the distance of the anomalously wide images from the free surface. The anomalously wide images were found to be near the surface, and they were used to determine defect character in three types of silicon. A ratio of 3 to 2 interstitial type to vacancy type was found in the phosphorous-doped Lopex; the ratio was more nearly unity in the other two types of silicon. The interstitial-type anomalously wide images were found to have a mean diameter of ~125 Å, whereas the vacancy-type anomalously wide images had a mean diameter of ~102 Å. Dislocations were not found to affect the radiation defects noticeably, nor did the thickness of the sample affect the types of images observed. In situ ion damage in silicon is visible as parallel and rotation Moiré pattern images of ~80 Å mean diameter. (Disser. Abstr.)

14875 THERMAL STABILITIES AND OTHER PROPERTIES OF IMPERFECTIONS IN IRRADIATED ALKALI HALIDES. Mumaw, Clayton Tedd. Pittsburgh, Carnegie–Mellon Univ., 1968. 341p.

Thesis.

The purpose of this work was to observe the stability of radiation damage in alkali halides under thermal, optical, or reirradiation treatment after x irradiation at different temperatures, and to relate the data to stabilities of specific defects if possible. Nominally pure KCl single crystals were x-irradiated at low temperature (generally 90 to 120°K), 30°C, or 40°C by lightly filtered (0–0.075 mm Al, or equivalent) x-ray sources operating at ~40 kV. X-ray-diffraction measurements of lattice expansion and diffraction profile width were made as a function of annealing above ~90°K and 40°C irradiation temperatures, and as a function of irradiation time at 30°C. Measurements of optical absorption in the 1900 to 20,000-Å range were made as a function of thermal annealing, optical bleaching, or reirradiation. Scattered measurements of both types were made using KBr x-irradiated under similar conditions. KCl thermal stabilities (resistance to decay during thermal annealing) for lattice expansion and the F optical absorption band increased with increasing irradiation temperature. Thermal stability of the F band also increased with irradiation dose at 30°C. The M band grew initially during annealing, and was characterized by the temperature T_{max} at which it reached a maximum. The M band data appeared describable by three balues of T_{max}. The highest T_{max} was tentatively attributed to inherent M-center stability. The remaining T_{max}'s may have been determined by the stabilities of anticenters created by irradiation in conjunction with negative-ion vacancies. This possibility was generally supported by comparisons of F-, M-, and uv-band annealing, and by expansion annealing or optical absorption regrowth data. Recombination of anticenters and negative-ion vacancies in KCl above the highest T_{max} was suggested by rough similarities in expansion and optical absorption annealing after 40°C irradiation. In this regard KCl appears to behave differently than KBr, NaCl, and LiF. In view of certain aspects of the KCl uv-absorption behavior during thermal annealing or optical bleaching in this work, it is not clear that any of the uv bands represent anticenter optical absorption. Similar F-band growth was seen for 1½-hr irradiation at either low temperature or 30°C. This was attributed to high irradiation intensities. Broadening of high-angle diffraction lines was seen after irradiation of KCl at 30 or 40°C, and after irradiation of KBr at 40°C. Broadenings were not seen after low-temperature irradiation of either KCl or KBr in spite of large measured expansions. A profile broadening analysis suggested that expansion gradients due to nonuniform damage could have accounted for most of the KCl broadening during irradiation at 30°C. It is likely that other sources of broadening operate in KBr. Lack of broadening for low-temperature irradiation was attributed primarily to filtration of the irradiation source. (Disser. Abstr.)

14876 OPTICAL SPECTRA AND CRYSTALLINE FIELD OF THE Eu^{3+} ION IN SOME RARE EARTH OXIDES. Linares, Christiane (Faculte des Sciences, Lyon). J. Phys. (Paris), 29: 917-25(Oct. 1968). (In French).

The luminescence of the Eu^{3+} ion in Lu_2O_3 is shown for the first time, then compared with those of the oxides Gd_2O_3: Eu^{3+} and Y_2O_3: Eu^{3+} studied formerly. Emission spectra are described and the lines observed identified; the most intense belong to the $^5D_0 \rightarrow {}^7F_2$ transition. The Eu^{3+} ion emission is interpreted in the crystal field approximation. On the basis of the best overall agreement found between calculations and experiments, the $A_n^m = B_n^m \langle r^n \rangle$ parameters are determined. (auth)

14877 INFLUENCE OF DEFECTS ON CHANNELING OF PHOSPHORUS IONS IN SILICON. Glotin, Ph. (CEN, Grenoble, France). J. Phys. (Paris), 29: 926-36(Oct. 1968). (In French).

The doping effects of 20-keV phosphorus ions bombarding a silicon target along the easy channeling ⟨100⟩ direction are studied. The ion gun is briefly described together with the apparatus for measuring implanted profiles (electrical and radioactive). Results are compared with Lindhard's theory, showing the influence of crystal structure on impurity distributions. Special attention is paid to nature of the defects as a function of depth into the material. By measuring annealing temperatures and

kinetics, it is possible, by comparison with well known defects in irradiated n-type silicon, to determine their structure and composition. In addition, defects are shown to play an important role in dechanneling of incoming ions and enhanced diffusion of impurities. Temperature influence is thus determined and applied to the electrical characteristics of diodes implanted at various temperatures. (auth)

14878 SIGN AND DEGREE OF IONIZATION OF MOLYBDENUM IN A NICKEL–MOLYBDENUM ALLOY. Kalinovich, D. F.; Kovenskii, I. I.; Smolin, M. D. (Inst. of Material Science Problems, Kiev). Sov. Phys.-Solid State (Engl. Transl.), 10: 1946-8 (Feb. 1969).

Translated from Fiz. Tverd. Tela, 10: 2480-3(Aug. 1968).

The diffusion and electrotransport of molybdenum in a nickel–8 at. % molybdenum alloy are considered over the temperature range 1000 to 1400°C. Diffusion is described by $D = 1.31 \exp [-54{,}900/kT]$ cm^2/sec. Molybdenum ions migrate toward the cathode during the electrotransport. The charge on the ions is −1.2 electron units. The density of the free electrons in the alloy (calculated from earlier data) is 0.92 electrons/atom. Donor–acceptor interaction takes place between the components of this alloy. (auth)

14879 STUDY OF SURFACE SELF-DIFFUSION OF TANTALUM BY FIELD-EMISSION MICROSCOPY. Pautov, D. M.; Sokol'skaya, I. L. (Leningrad State Univ.). Sov. Phys.-Solid State (Engl. Transl.), 10: 1941-5(Feb. 1969).

Translated from Fiz. Tverd. Tela, 10: 2473-9(Aug. 1968).

Processes of surface self-diffusion of tantalum in an electrostatic field and without the field were studied in a Mueller field-emission microscope at 1200 to 1400°K and electric field intensities up to attainable limits. Photographs show the change in the emission image of a tip during surface migration in the field (reconstruction). The relation between electronic field-emission current and reconstruction time was determined at various temperatures in a steady field. The activation energy for this process Q_F was found from these data using the slope of the straight line $\log t = f(10^4/T)$ (t is reconstruction time and T is temperature) ($Q_F = 1.9$ eV for $F = 1.5 \times 10^7$ V/cm); the activation energy for zero field Q_0 (smoothing) proved to be 2.4 eV. The coefficient of surface tension of tantalum was measured ($\sigma = 1950$ dyn/cm). From the data obtained, an assumption is made regarding the final form of the emitting crystal. Doubts are expressed as to the correctness of the present method of estimating the effect of the field on the activation energy for reconstruction. (auth)

14880 CHANNELING OF ELECTRONS IN THIN SINGLE CRYSTALS OF COPPER. Grachev, B. D.; Komar, A. P.; Korobochko, Yu. S.; Mineev, V. I. (Kalinin Polytechnic Inst., Leningrad). Sov. Phys.-Solid State (Engl. Transl.), 10: 1894-8(Feb. 1969).

Translated from Fiz. Tverd. Tela, 10: 2408-14(Aug. 1968).

The results of an experimental study of the channeling of 50-keV electrons in thin single-crystal copper films are reported. A Rutherford distribution of scattered electrons is obtained for thin films. As the film thickness increases, there is a deviation from the Rutherford distribution caused by multiple scattering. When the direction of motion coincides with any of the closest-packed crystal directions, the output of scattered electrons is increased by about 25%. This increase is roughly constant in the range of scattering angles from 100 to 167° investigated. A localized increase in the output of scattered electrons is observed in the closest-packed crystal directions, caused by channeling of the scattered electrons. (auth)

14881 INVESTIGATION BY LOW-ENERGY ELECTRON DIFFRACTION OF SCANDIUM FILMS ADSORBED ON A (110) TUNGSTEN SURFACE. Gorodetskii, D. A.; Yas'ko, A. A. (Shevchenko State Univ Kiev). Sov. Phys.-Solid State (Engl. Transl.), 10: 1812-7(Feb. 1969).

Translated from Fiz. Tverd. Tela, 10: 2302-10(Aug. 1968).

Low-energy diffraction was used to study the structure of scandium films on tungsten (110) surfaces. Ordered structures with large lattice constants appeared during the initial stages of scandium deposition ($1 - 4 \times 10^{14}$ at./cm^2), but after annealing they converted into more stable structures in which one scandium atom was associated with three tungsten atoms. The present investigation is concerned with the diffraction pattern changes which occur during the transition to thicker scandium films down to the formation of α-scandium crystals oriented with their (0001) plane parallel to the substrate. Before the α-scandium (0001) films formed, transition films were observed with structures close to that of the substrate and the α-scandium (0001) face. The effect of substrate temperature on the orientation of the scandium films was studied. When the scandium films were annealed the material contracted into three-dimensional crystals. It was shown that the initial conditions considerably affected the formation of the ordered scandium film. The changes in film structure and surface work function were compared. (auth)

14882 MAGNETORESISTANCE AND FERMI-SURFACE ANISOTROPY IN VANADIUM METAL. Nelson, K. S.; Stanford, J. L.; Schmidt, F. A. (Ames Lab., Iowa). Phys. Lett., 28A: 402-3(Dec. 30, 1968).

What is believed to be the first experimental observation of Fermi-surface anisotropy in vanadium metal is reported. The high-purity (residual resistance 272) vanadium single-crystal was prepared by an electro-transport technique. The data indicate that the Fermi surface of V is qualitatively similar to that of Nb and Ta. (auth)

14883 ELASTIC MODULI AND ULTRASONIC ATTENUATION OF POLYCRYSTALLINE URANIUM FROM 4.2 TO 300°K. Rosen, M. (Nuclear-Research-Centre-Negev, Beer-Sheva, Israel). Phys. Lett., 28A: 438-9(Dec. 30, 1968).

Anomalies in the ultrasonic attenuation in uranium at 36°K confirm the existence of a structural, rather than magnetic change. It is suggested that this transition is induced by an electron-transfer mechanism operating below 100°K. (auth)

14884 ANISOTROPIC NUCLEAR MAGNETIC RELAXATION IN METALLIC SCANDIUM. Fradin, F. Y. (Argonne National Lab., Ill.). Phys. Lett., 28A: 441-2(Dec. 30, 1968).

The orientation dependence of the nuclear magnetic relaxation rate in single-crystal scandium is presented. The relaxation is primarily due to the orbital hyperfine interaction. (auth)

14885 CRYSTAL FIELD IN RARE-EARTH TRICHLORIDES. IV. PARAMETER VARIATIONS. Curtis, M. M. (Dept. of Theoretical Physics, Oxford); Newman, D. J.; Stedman, G. E. J. Chem. Phys., 50: 1077-85(Feb. 1, 1969).

Parameter variations are determined for changes in the ligand coordination angles and distances in Pr^{3+}: $LaCl_3$. Parameters for Sm^{3+} and Er^{3+} substituted in $LaCl_3$ are also calculated. These results are used in conjunction with the superposition approximation to discuss the variation of parameters down the rare-earth series in the trichlorides and to predict values of the dynamic orbit–lattice parameters in $PrCl_3$. (auth)

14886 EFFECTS OF LASER IRRADIATION ON THE γ-RAY-INDUCED COLOUR CENTERS IN NaCl. Agarbiceanu, I.; Berenyi, C.; Motoc, Cornelia (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys., 13: 809-10(1968).

NaCl crystals were irradiated first with 3.5×10^7 R γ rays and then with a CO_2 laser (10.6 μ) operating at 5W. The rate of disappearance of the F band with laser irradiation was determined and found to indicate very slow bleaching of the color centers. A small heating effect accompanied the bleaching. Microscopic examination showed some laser-induced changes, these consisting of bubbles and shift of cleavage lines. A mechanism is proposed in which the laser beam excites acoustic vibrations and resonance absorption occurs. (D.L.C.)

14887 SECOND RPA FOR THE PLASMA FREQUENCY OF AN ELECTRON GAS IN A PHONON FIELD. Babcenco, A.; Corciovei, A.; Grecu, D. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys., 13: 783-94(1968).

The collective properties of an electron gas interacting with a free phonon field are examined. The equation-of-motion method is applied to the electron-hole pair operators, considered to describe the collective oscillations of the electron density fluctuations. A second random phase approximation in the products between electron-hole pair operators and phonon coordinates, allowing to take into account the thermal properties of the lattice, is developed. The dispersion relation for plasmon excitation is established and the temperature dependence of the collective electron oscillations is discussed. (auth)

14888 YADERNYI MAGNITNYI REZONANS. VYPUSK II. (Nuclear Magnetic Resonance. Issue II). Borodin, P. M. (ed.). Leningrad, Izdatel'stvo Leningradskogo Universiteta, 1968. 208p.

Twenty-five papers reporting the results of laboratory experiments on nuclear magnetic resonance made in the Leningrad State University in 1965–66 are compiled. The topics discussed are the study of the structure of diamagnetic solutions of electrolytes by means of NMR, double resonance in solutions of asphalt and in crude petroleum, effect of heterogeneous magnetic fields on the signal form of free nuclear precession, association of hydrogen fluoride in the systems HF–H_2O, HF–D_2O, and HF–dioxane from NMR data, study of molecular interaction in the system HF–HNO_3–

H_2O, chemical displacement and relaxation time of ^{31}P in solutions of some phosphor organic compounds, investigation of complex formation in some solutions of antimony trichloride, NMR of ^{31}P and ^{19}F in some solutions of phosphor organic compounds, concentration dependence of the chemical displacement of the NMR signal of ^{19}F in silicon fluoride solutions, determination of the structure of aqueous solutions of electrolytes by means of NMR, investigation of some electrolyte solutions by the spin echo method, relation of self-diffusion coefficient and mutual diffusion, NMR of ^{19}F in $NaMnF_3$, investigation of stannic acid by proton magnetic resonance method, spin–lattice relaxation of protons in structured solutions of polymers and efficiency of ultrasonic influence on nuclear spin system in liquids, apparatus for the investigation of the acoustics of NMR, possibility of improvement of some characteristics of nuclear resonance generators, effect of conducting spherical screens on the process of release of polarizing fields during production of free nuclear processes, nuclear magnetic relaxation in liquids in contact with solid surfaces, quasi stationary spectrometer of high resolution, production of square-wave current pulses for pulse gradients in spin echo methods, NMR pulse spectrometer for study of solids, measurement of the spin–lattice relaxation time in intermediate fields, and nuclear magnetic relaxation in adsorbing liquids. (J.S.R.)

14889 NEUTRON DIFFRACTION BY GERMANIA, SILICA, AND RADIATION-DAMAGED SILICA GLASSES. Lorch, E. (Univ. of Birmingham, Eng.). J. Phys., C (London), 2: 229-38 (Feb. 1969).

Neutron-diffraction patterns for vitreous germania, synthetic vitreous silica, and radiation-damaged synthetic silica were obtained to 18 $Å^{-1}$. With the use of a special resolution function, the results were analyzed to produce "radial distribution functions" free of truncation error ripples. The function for vitreous germania showed considerable improvement on previous x-ray measurements. Evidence for the concept of ordered groups of molecules in the glass was obtained from the radiation-damaged experiments. (auth) (UK)

14890 DOPING SOLIDS WITH IONS. Dearnaley, Geoff; Freeman, J. Harry (Atomic Energy Research Establishment, Harwell, Eng.). New Sci., 41: 282-4(Feb. 6, 1969).

Although diffusion is the established way of making semiconductor devices, there is growing industrial interest in an alternative method—ion implantation. This offers several advantages, notably that of operating at lower temperatures. Machines are now being built in Britain and elsewhere to make integrated circuits in large quantities by this method. (auth) (UK)

14891 RADIATION EFFECT ON PHYSICAL PROPERTIES OF LiF SINGLE CRYSTALS. Golubeva, L. A.; Kalnin, D. O.; Smiryagina, S. A.; Shishelov, A. A. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser., No. 5, 9-16(1968). (In Russian).

The effect of thermal treatment and x and γ irradiation on the electric conductivity, the dielectric power factor, the thermal conductivity, and the optical density of lithium fluoride single crystals was studied. The changes in the crystal characteristics were found to depend on the kind and concentration of defects resulting from the irradiation. (auth)

14892 ON THE TEMPERATURE DEPENDENCES OF THE MAGNETIC ELECTRICAL RESISTIVITIES IN Pr AND Nd. Watabe, A.; Kasuya, T. (Tohoku Univ., Sendai). J. Phys. Soc. Jap., 26: 64-73(Jan. 1969).

Temperature dependences of the electrical resistivities due to the s–f exchange interaction and quadrupole scattering are calculated for Pr and Nd of the hcp, fcc, and the La-type crystal structures. The magnetic states of 4f electrons are determined from other experimental results. In general, reasonable agreement between the calculation and the experiment is obtained both in the absolute values and in the temperature dependences. The sharp discrepancy on the temperature dependences of the resistivities for the two different samples of Pr is attributed on the basis of the present calculation to the possibility that the old sample is hcp-rich and the new sample fcc-rich. (auth)

14893 MAGNETIC SUSCEPTIBILITIES OF RARE-EARTH-INDIUM COMPOUNDS: RIn_3. Buschow, K. H. J. (Philips' Research Labs., Eindhoven, Netherlands); de Wijn, H. W.; van Diepen, A. M. J. Chem. Phys., 50: 137-41(Jan. 1, 1969).

The magnetic properties and the lattice parameters for 13 compounds of the composition RIn_3 (Cu_3Au structure) are reported. The magnetic measurements have been performed between 4.2° and 500°K with magnetic fields up to 30 kOe. With the exception of compounds with R = La, Sm, Y, and Yb, Curie–Weiss behavior is observed in the high-temperature region. At low temperatures, the magnetic behavior for compounds in which R = Ce, Nd, Sm, Gd, Tb, Dy, Ho, and Er is ascribed to antiferromagnetic ordering. In the case of $PrIn_3$, magnetic ordering is prevented by crystalline fields. The splitting of the J = 4 state of Pr^{3+} by cubic crystalline fields has been calculated for various combinations of fourth- and sixth-order potentials. Possible energy diagrams are presented. (auth)

14894 ELECTRON SPIN RESONANCE ABSORPTION SPECTRUM OF THE AsO_2^{2-} MOLECULE-ION IN γ-IRRADIATED SINGLE-CRYSTAL CALCITE. Marshall, S. A. (Argonne National Lab., Ill); Serway, R. A. J. Chem. Phys., 50: 435-9(Jan. 1, 1969).

An electron spin resonance absorption spectrum corresponding to S = ½, I = ³⁄₂, and exhibiting orthorhombic symmetry has been observed in γ-irradiated single-crystal calcite. At 4.2°K, the spin-Hamiltonian parameters are $g_{zz} = 2.0150$, $g_{xx} = 1.9991$, $g_{yy} = 1.9910$, $A_{zz} = -152$ MHz, $A_{xx} = 614$ MHz, $A_{yy} = -173$ MHz, $(g^n\beta^n/h) = -7.24 \times 10^{-4}$ MHz/Oe, $e^2qQ = 16.2$ MHz, and $\eta \cong 0$. The paramagnetic defect associated with this spectrum is identified as the AsO_2^{2-} molecule–ion which is located at carbonate ion sites with its plane coincident with that of the carbonate ions. From the hyperfine structure splittings and the g-tensor anisotropy, it is deduced that the unpaired electron has approximately 1% 4s, 96% 4p, and 3% 4d character and that it is almost completely localized on the arsenic atom. (auth)

14895 TRANSITIONS RESPONSIBLE FOR THE FLUORESCENCE OF THE ACTIVATOR ION Eu^{3+} IN SOME OXYGENATED COMPOUNDS WITH RARE EARTH BASE. EFFECT OF THE SYMMETRY OF THE SITE. Linares, Christiane; Gaume-Mahn, Francoise (Faculte des Sciences, Villeurbanne, France). Compt. Rend., Ser. A and B, 267: 1094-6(Nov. 13, 1968). (In French).

The fluorescence emission of the Eu^{3+} ion was studied in La_2O_3, $LaAlO_3$, $GdAlO_3$, and Gd_2O_3. For each spectrum, the number of lines observed, the presence or absence of the forbidden transition $^5D_0 \rightarrow {}^7F_0$, as well as the relative intensities of the $^5D_0 \rightarrow {}^7F_2$ and $^5D_0 \rightarrow {}^7F_1$ lines are in good agreement with the symmetry of the site of the activator ion Eu^{3+}. (tr-auth)

14896 A STUDY OF THE MAGNETIC INTERACTIONS IN $\alpha - Fe_2O_3$ THROUGH SCATTERING OF NEUTRONS BY SPIN WAVES. Samuelsen, E. J. (Institutt for Atomenergi, Kjeller, Norway). Physica, 34: 241-5(1967).

The velocities of spin waves propagating in two crystallographic directions were determined experimentally at room temperature. These velocities are theoretically expressed in terms of four nearest-neighbor exchange interaction constants. It is shown that the interactions involving Fe–O–Fe bonding angles close to 90° are of considerable strength. (auth)

14897 MAGNETIC PROPERTIES OF PRASEODYMIUM TELLURIDES. Vigileva, E. S.; Pechennikov, A. V.; Chechernikov, V. I.; Yarembash, E. I. (Inst. of General and Inorganic Chemistry, Moscow. Moscow State Univ.). Izv. Akad. Nauk SSSR, Neorg. Mater., 4: 1586-7(Sept. 1968). (In Russian).

Chemical, differential thermal, and x-ray analysis were made of the crystal structure of synthesized specimens of praseodymium tellurides (PrTe, Pr_2Te_3, Pr_4Te_7, and $PrTe_3$). Their magnetic properties were determined at 77 to 300°K. Data obtained show that in the range of temperatures examined the magnetic susceptibility of the material follows the Curie–Weiss law. The curve of temperature versus susceptibility varied with the content of Pr diminishing from PrTe to $PrTe_3$. The Curie paramagnetic temperature and effective magnetic moment were calculated. It was found that at lower temperatures the praseodymium tellurides are antiferromagnetic. (R.V.J.)

14898 LATTICE VIBRATIONS OF VANADIUM BY INELASTIC SCATTERING OF SLOW NEUTRONS. Roy, A. P.; Thaper, C. L.; Iyengar, P. K. (Atomic Energy Establishment, Bombay). Physica, 34: 384-6(1967).

High-resolution measurements on the V lattice vibration spectrum were made in the interval of 18 to 36 MeV of inelastically scattered neutrons. The inelastic spectrum scattered at an angle of 100° shows that the high-energy peak in the phonon frequency distribution at 28 MeV is resolved into two peaks at 27 and 30 MeV. The lattice vibration spectra of V and Nb are compared. (D.L.C.)

14899 PECULIAR FEATURE OF THE DIELECTRIC BREAKDOWN IN THE FIELD OF A STRONG IONIZING RADIATION. Knizhnik, E. I.; Pedchenko, K. S. (Inst. of Physics, Kiev). Elektrichestvo, No. 3, 65-7(1968). (In Russian).

The breakdown voltage of dielectrics subjected to ionizing radiation depends on the dielectric thickness in a complex way. With thin dielectrics, the breakdown voltage is practically independent of the specific heat evolution due to radiation. With medium-

thickness dielectrics, the breakdown voltage depends on the specific radiation heat evolution and may reach a maximum. With thick dielectrics, reduction of the radiation intensity with the thickness must be taken into account; the breakdown voltage depends on the specific heat evolution and falls off as the specimen thickness increases. Plots of breakdown voltage vs. thickness, for porcelain, quartz, polystyrene, and glass are shown; they are estimated from this formula: $U_{Cr} = AE_{Br}\, h^{\frac{1}{2}} \exp|-a(T_{max} - T_w)| = A\sqrt{2}\, E_{Br}\, \delta^{\frac{1}{2}} \exp[-a\,(q_v/2\lambda)\,\delta^2]$, where A is a constant in $cm^{\frac{1}{2}}$, δ = dielectric thickness, $h = 2\delta$, T_{max} = maximum temperature in dielectric, T_w = wall temperature, λ = thermal conductivity. Irradiation resistance of the above materials was investigated by V. J. Linnenbom (Insulation, 1962, v. 8, no. 1-2, 80) and E. B. Waddington (AEI Engineering, 1962, v. 2, no. 1, 24). The authors' experiments show that the presence of noticeable amounts of boron in glass sharply increases the dose of absorbed neutron radiation; hence, in high-voltage equipment working in neutron fields, quartz glass is preferable to boron-containing glass. (ATD)

14900 MAGNETIC AND SEMICONDUCTING PROPERTIES OF SmB_6. Menth, A. (Bell Telephone Labs., Murray Hill, N. J.); Buehler, E.; Geballe, T. H. Phys. Rev. Lett., 22: 295-7 (Feb. 17, 1969).

SmB_6 has been found to show no magnetic ordering down to a temperature of 0.35°K. This is interpreted to mean that the Sm ion is in its nonmagnetic divalent configuration at low temperatures and find direct evidence for the changing electronic configuration of Sm from trivalent to divalent with decreasing temperature in the observed semiconducting behavior at low temperatures. (auth)

14901 ORIGIN OF DEFECT STATES IN CALCIUM TUNGSTATE. Sayer, M.; Souder, A. D. (Queen's Univ., Kingston, Ont.). Can. J. Phys., 47: 463-71(Feb. 15, 1969).

A comparison has been made of thermoluminescence and thermally stimulated current in single crystals of calcium tungstate either doped with impurities or nominally pure but excited by ionizing radiation. Both effects were large in the case of monovalent impurities with glow peaks near 260°K being characteristic of the impurity and peaks near 160°K arising from an enhancement of a structure which normally results from radiation damage. Trivalent impurities had a lesser effect with the production of glow peaks near 300°K. The structures responsible for the prominent glow peaks are suggested to be: 260°K—monovalent ions in calcium sites; 154/160°K—oxygen vacancies associated with either a W^{5+} or a monovalent ion at a calcium site; and 300°K—calcium vacancies. The occupancy of electron and hole traps is found to be related. This relationship is used to deduce information regarding the excitation mechanism for free holes and electrons in calcium tungstate. (auth) (Canada)

14902 DIRECTIONAL EFFECTS OF SPUTTERING OF A SINGLE GOLD CRYSTAL UNDER BOMBARDMENT BY HEAVY IONS. Van Wijngaarden, A.; Reuther, E.; Bradford, J. N. (Kansas State Univ., Manhattan). Contract AT(11-1)-1766. Can. J. Phys., 47: 411-17(Feb. 15, 1969).

The (111) surface of a single gold crystal was bombarded by monoenergetic ion beams of ^{1}H, ^{4}He, ^{11}B, ^{14}N, ^{20}Ne, and ^{40}Ar in the energy range 10 to 60 keV. The total positive charge liberated from the crystal surface under the ion bombardment was studied as a function of crystal orientation. The yield showed strong minima when the ion beam entered the crystal along the low index directions. The angular full width at half depth of these minima was studied as a function of energy and atomic number of the projectiles. The results are in good agreement with a theory based on a $1/R^2$ ion–atom potential. (auth) (Canada)

14903 VARIATION OF THE TEMPERATURE DEPENDENCE OF THE DIELECTRIC CONSTANT OF QUARTZ PLATES OF THE YXL/35°31' SECTION UNDER THE INFLUENCE OF NEUTRON AND GAMMA IRRADIATION. Starodubtsev, S. V.; Chubarov, L. B. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk SSR, Neorg. Mater., 3: 1704-5(1967). (In Russian).

In order to check the hypothesis that the temperature at which a marked increase of the permittivity occurs in quartz plates is related to the concentration of defects in the quartz crystal lattice, a study was made of the temperature dependence of the permittivity of quartz plates before and after their irradiation in the active zone of a nuclear reactor and in the field of a powerful ^{60}Co gamma source. Repeated heating and cooling of the quartz plate did not alter the temperature dependence of the permittivity. The results show that the increase in the concentration of lattice defects caused by irradiation of plates of crystalline quartz of the yxl/35°31' section leads to an increase in the temperature at which a marked increase of the permittivity begins to take place. The magnitude of the change in the temperature at which a marked increase of the permittivity occurs after irradiation is a measure of the radiation damage to the plate caused by the irradiation. (ATD)

14904 ABSORPTION EDGE OF FAST ELECTRON IRRADIATED GERMANIUM. Gerasimov, A. B.; Rogachev, A. A.; Eristavi, G. L. Fiz. Tekh. Poluprov., 2: 1531-4(Oct. 1968). (In Russian).

Results are presented of an investigation of the region of direct optical transitions of germanium irradiated by 5-MeV electrons at liquid nitrogen temperature, and annealed isochronically up to 400°K. One of the goals of the work was obtaining data concerning the introduction of radiation defects and their interaction with the initial lattice imperfections at low temperatures. Samples of n-type Ge alloyed with antimony and arsenic at concentrations from 10^{14} to 3×10^{19} cm^{-3} were studied. For absorption coefficient measurements, samples were used that were prepared in the form of plane-parallel polished films of thickness 40 μ. (tr-auth)

14905 KINETICS OF NEUTRON IRRADIATED Ge IMPURITY PHOTOCONDUCTIVITY. Novikov, S. R.; Rubinova, E. E. Fiz. Tekh. Poluprov., 2: 1500-5(Oct. 1968). (In Russian).

The kinetics of impurity photoconductivity in n-type Ge, irradiated by reactor fast neutrons at ~70°C were studied. Samples with initial concentration of Sb of $\sim 2 \times 10^{15}$ cm^{-3} were irradiated by integral beams of fast neutrons from 4.7×10^{14} to 2.3×10^{15} cm^{-2}. The rate of decrease exceeded the rate of increase of photocurrent in all wavelength areas studied. Cross sections were determined for capture of photons, electrons, and holes by levels $E_c - 0.1$, $E_c - 0.2$, $E_c - 0.32$, $E_v + 0.18$, and $E_v + 0.07$ eV. (tr-auth)

14906 MECHANISM OF ION FORMATION AND ION EMISSION DURING SPUTTERING. Benninghoven, A. (Univ., Cologne). Z. Phys., 220: 159-80(1969). (In German).

It is demonstrated that the degree of ionization of secondary particles emitted from a solid surface under ion bombardment cannot be predicted by the Saha–Langmuir equation. For an understanding of the ion emission, it is necessary to separate the process of ion formation and the following emission. There exists a great number of different processes resulting in the formation of an ion on the surface. These processes can be disentangled by means of a systematical mass spectrometrical analysis. The probability for an ion to leave the surface without neutralization depends on various parameters as ionization potential and velocity of the emitted particle, work function and temperature of the surface, etc. (auth)

14907 NUCLEAR-MAGNETIC-RESONANCE STUDIES OF FERROELECTRICITY IN NORMAL AND IRRADIATED ROCHELLE SALT. Oja, T.; Casabella, P. A. (Rensselaer Polytechnic Inst., Troy, N. Y.). Phys. Rev., 177: 830-8(Jan. 10, 1969).

The ferroelectric properties of Rochelle salt have been studied by means of two new techniques based on the ^{23}Na NMR. In the first technique, the separation between a pair of ^{23}Na quadrupolar satellites is used as a measure of the spontaneous polarization of the crystal. Using this method, the effects of electric fields and γ irradiation on the polarization have been studied. The irradiation caused the spontaneous polarization to decrease in magnitude, but to persist over a wider temperature range than in an unirradiated crystal. In the second technique, a pair of quadrupolar satellites was identified as arising from oppositely polarized domains. The relative intensities of these satellites provides a measure of the fraction of the crystal polarized in the forward and reverse directions. Under the influence of an applied electric field, the relative intensities of the two satellites change. By studying these changes versus applied electric field, "quasistatic" hysteresis loops have been obtained which have a very low coercive field (25 V/cm). When the crystal is irradiated with γ rays, these hysteresis loops split into double loops. Finally, domain dynamics were studied by measuring the relative intensities of these satellites versus time after an electric field had been switched. The time required for polarization reversal was observed to depend on the magnitude of the applied electric field. (auth)

14908 CRITICAL SCATTERING OF SOUND IN RARE-EARTH METALS. Pollina, R. J.; Luethi, B. (Rutgers-The State Univ., New Brunswick, N. J.). Phys. Rev., 177: 841-7(Jan. 10, 1969).

Ultrasonic attenuation measurements in the vicinity of the Néel temperature are presented for terbium, dysprosium, and holmium. Longitudinal sound waves along the c axis exhibit a large critical attenuation, whereas shear waves show only a small but measurable effect in dysprosium. The spin–phonon coupling responsible for this critical attenuation is predominantly of volume-magnetostrictive character for longitudinal waves and of linear-magnetostrictive (single-ion-type) character for shear waves. Longitudinal wave attenuation in the paramagnetic region gives the following

critical exponent $\eta[\alpha \propto \omega^2(T - T_N)^{-\eta}]$: terbium 1.24 ± 0.1, dysprosium 1.37 ± 0.1, holmium 1.0 ± 0.1. Shear waves in dysprosium give $\eta = 0.8 \pm 0.15$. These exponents, with the exception of the shear-wave case, can be fairly well accounted for by recent theories of ultrasonic attenuation at magnetic phase transitions. The critical exponent η for shear waves in Dy, together with the magnitude of the effect, can tentatively be explained with present theories by considering higher-order terms in the spin–phonon coupling. For temperatures very close to T_N, the attenuation remains finite. This is shown to be an impurity effect. (auth)

14909 DIRECTION OF EASY MAGNETIZATION IN GADOLINIUM. Milstein, Frederick (Rand Corp., Santa Monica, Calif.); Robinson, Lawrence Baylor. Phys. Rev., 177: 904-9 (Jan. 10, 1969).

The direction of easy magnetization in Gd is studied as a function of temperature and pressure. The pertinent experimental results have already been given by Robinson, Milstein, and Jayaraman. A Gd sample was used as the core of a small transformer; a constant input voltage was supplied to this transformer. The secondary voltage was monitored as a function of temperature at several constant pressures. The secondary voltage of the transformer, being proportional to the permeability of the sample, is a sensitive indicator of changes in magnetic structure in the Gd sample. Typically, the secondary voltages behave as follows as the temperature of the transformer is lowered: A sharp rise in the secondary voltage occurs at the Curie temperature, followed by another sharp rise at a temperature well below the Curie point. The magnitude of the secondary voltage at this latter transition is from two to three orders of magnitude greater than at the transition from the paramagnetic to the ferromagnetic state. This transition is interpreted as a magnetic transition in which the direction of easy magnetization in Gd deviates from the c axis. The angle of deviation is discussed in terms of the (small) anisotropy constants resulting from the weak crystalline field in Gd. In terms of the output voltage, one is able to obtain the relative deviations of the direction of easy magnetization from the c axis. The temperatures, as a function of pressure, at which the maximum deviations occur can also be obtained. As the temperature is lowered further, the direction of easy magnetization starts to approach the c axis again. Comparisons are made with other measurements of this angle of deviation. (auth)

14910 CALORIMETRIC INVESTIGATION OF HYPERFINE INTERACTIONS IN METALLIC Ho AND Tb. Krusius, M.; Anderson, A. C.; Holmstroem, B. (Technical Univ. of Helsinki, Otaniemi, Finland). Contract AF61(052)-956. Phys. Rev., 177: 910-16(Jan. 10, 1969).

The specific heats of metallic Ho and Tb have been measured between 0.03 and 0.5°K, a temperature range in which the nuclear (hyperfine) heat capacity predominates. The data are fitted with theoretical Schottky curves, using magnetic-dipole hyperfine-interaction parameters $\alpha' = +0.319$°K and $\alpha' = +0.149$°K, and electric quadrupole coupling constants $P = +0.004$°K and $P = +0.0158$°K for Ho and Tb, respectively. For Tb, these values are in agreement with the parameters obtained from nuclear-magnetic-resonance measurements. An earlier suggestion that a cooperative nuclear–nuclear interaction might be present in Tb is here shown to have been based on an erroneous temperature scale. A detailed description of the calorimeter is presented. (auth)

14911 RESONANCE STUDIES IN FERROMAGNETIC Fe_2B AND Fe_2Zr. Weisman, I. D.; Swartzendruber, L. J.; Bennett, L. H. (National Bureau of Standards, Washington, D. C.). Phys. Rev., 177: 465-71(Jan. 10, 1969).

The hyperfine magnetic fields and quadrupole interactions in Fe_2B and Fe_2Zr are explored by nuclear magnetic resonance and the Moessbauer effect. The anisotropy found in the Fe_2B Moessbauer spectra can be interpreted as a superposition of hyperfine patterns arising from an anisotropic magnetic field and electric field gradient in combination with either two magnetically inequivalent Fe sites (such as was observed in Fe_2Zr) or a two-dimensional distribution of magnetization directions. Assuming the former, the two magnetic fields are found to be 252 ± 2 and 244 ± 2 dT at T = 4.2 K. The B resonance frequency in Fe_2B shows a $T^{\frac{3}{2}}$ dependence with some low-temperature deviations which can be understood in terms of a gap arising from magnetocrystalline anisotropy and spin-wave demagnetization. The constants of proportionality in the spin-wave approximation, C (the coefficient of the $T^{\frac{3}{2}}$ term) and D (the coefficient of the $T^{\frac{5}{2}}$ term), were extracted. It is found that $D/C = (1.0 \pm 0.4) \times 10^{-3}$ and that the gap temperature $T_g \leq 1$ K. The measured pressure variations $\partial\nu/\partial P$ of the ^{11}B and ^{91}Zr frequencies are, respectively, -21 ± 2 and 31 ± 2 Hz bar^{-1}. (auth)

14912 LINE SHAPE OF THE MOESSBAUER LINE IN THE PRESENCE OF ULTRASONIC VIBRATIONS WITH DECAYING AMPLITUDES. Kornfeld, Gertrude (Univ. of Albuquerque, N. Mex.). Phys. Rev., 177: 494-501(Jan. 10, 1969).

A Moessbauer source that executes ultrasonic vibrations with decaying amplitudes has a center-line fraction that increases with time; the center line of the emitted radiation can be even narrower than half the natural width. The nth band fraction has its maximum when $k^2\langle x^2\rangle \approx n^2$; sidebands can be either narrowed or widened; narrowing can take place with large initial amplitudes that decrease or small initial amplitudes that increase. Random fluctuations in ultrasonic amplitudes might explain the narrow side bands in Cranshaw and Reivari's ultrasonic experiment as a superposition of widened and narrowed lines. (auth)

14913 RADIATIVE RECOMBINATION IN HIGHLY EXCITED CdS. Benoit a la Guillaume, Claude; Debever, Jean-Marie; Salvan, Frank (Centre National de la Recherche Scientifique, Paris). Phys. Rev., 177: 567-80(Jan. 10, 1969).

The processes involved in the laser effect in CdS excited by electron bombardment have been studied with the aid of an experimental technique allowing the spectral dependence of the optical gain to be obtained. It is shown that at least three different processes can lead to a laser effect in CdS. The first, which corresponds to a low gain, is due to the annihilation of a free exciton with the emission of a photon and an LO phonon. The second, yielding a medium gain, is due to an exciton–exciton interaction; and the third, which results in a high gain, involves an exciton–electron interaction. These last two processes have been studied theoretically, and the results are compared with the experimental data. (auth)

14914 THEORY OF MODULATION EFFECTS IN RESONANT NUCLEAR DISORIENTATION EXPERIMENTS. Wilson, G. V. H. (Monash Univ., Clayton, Victoria). Phys. Rev., 177: 629-38 (Jan. 10, 1969).

An analysis is made of modulation effects in "resonant nuclear disorientation" experiments on radioactive nuclei which have been polarized by hyperfine interaction at low temperatures in ferromagnetic host metals. The inhomogeneously broadened nuclear magnetic resonance is detected through the destruction of the γ radiation anisotropy by a resonant-frequency-modulated rf field. It is shown that to a good approximation the observed line shape is determined solely by the modulation amplitude and the distribution of hyperfine magnetic fields; for large rf fields, the signal amplitude depends separately upon the modulation amplitude and frequency. For finite rf field intensities, the signal amplitude also depends upon a parameter k which is closely related to the saturation behavior which would be observed in the absence of inhomogeneous broadening. At high modulation frequencies, the dependence of the signal amplitude upon k is easily calculated, and this should permit experimental determinations of k values. Independent determinations should also be possible from studies of the time rate of destruction of the γ radiation anisotropy immediately after applying a resonant rf field. (auth)

14915 COLOUR CENTRES PRODUCTION IN SODIUM DOPED KBr AT 80°K. Giuliani, G. (Univ. of Pavia, Italy. CNR, Rome). Solid State Commun., 7: 79-82(Jan. 1969).

Sodium impurities enhance both the α- and the F-centre production by x rays at 80°K. In the case of α centres, the enhancement is due to the stabilization by sodium impurities of interstitial bromine ions created in pairs with α centres. The enhancement of the F-centre production is related to the formation of V_1 centres (which seem to be some kind of interstitial trapped by sodium impurities). (auth) (UK)

14916 DOMAIN SWITCHING IN IRRADIATED FERROELECTRIC KH_2PO_4 OBSERVED BY ELECTRON SPIN RESONANCE. DuVarney, Raymond Charles Jr. Worcester, Mass., Clark Univ., 1968. 57p.

Thesis.

While potassium dihydrogen orthophosphate KH_2PO_4 (KDP) is a well known ferroelectric material, very little work has been published concerning the effects of radiation on it. The results of some radiation damage studies are reported in which electron spin resonance (ESR) is used as a probe to study the microscopic radiation-damage sites and to observe the influence of an applied electric field on these sites. It is found that the switching of the ferroelectric domains can be observed directly on the microscopic level and that the observed damage sites are themselves microscopically reversible. Radiation-damaged KDP exhibits strong ESR signals when irradiated and studied at 77°K. The paramagnetic species has been identified as the $\cdot OPO_3H^-$ radical which results from the loss of a hydrogen atom from a $H_2PO_4^-$ ion. For arbitrary orientations of the crystals the observed spectrum consists of 16 lines which arise from the eight magnetically inequivalent oxygen sites together with the 32 Gauss isotropic splitting

associated with the ^{31}P hyperfine coupling. When the magnetic field is perpendicular to the ferroelectric c-axis, the two upper oxygen sites on a single PO_4^{3-} tetrahedron become magnetically equivalent to each other. After the radiation-damaged crystal is polarized with a 9 kV/cm electric field applied parallel to the c-axis, it is found that two of the doublets arising from domains of one polarity have increased in intensity while the two doublets from domains of the opposite polarity have decreased. The effect can be reversed by using polarizing fields of the opposite polarity. It is concluded that the polarization mechanism is able to transfer the unpaired electron spin density from an upper oxygen site to a lower oxygen site or vice versa. Using the ESR spectrum, then, to indicate the degree of polarization in a sample, it is also found that x irradiation of a polarized crystal causes a loss of polarization, possibly due to radiation effected domain wall migration. (TSS) (Diss. Abstr.)

14917 NUCLEAR POLARIZATION BY DYNAMIC COOLING. Kozhushner, M. A. (Inst. of Chemical Physics, Moscow). Zh. Eksp. Teor. Fiz., 56: 246-55(Jan. 1969). (In Russian).

The dynamic cooling technique for enhancing nuclear polarization was investigated theoretically. The electron-spin-system temperature decreases when the EPR is saturated by an alternating field whose frequency is shifted relative to the center of the EPR line. The nuclear-spin-system temperature also strongly decreases in the presence of strong coupling between the electron and nuclear spin systems; this leads to an increase of the nuclear polarization. Cases of high and low temperature are considered. A criterion of efficiency of the method is obtained, and an equation is derived for the effective spin temperature of the system. Since large paramagnetic center concentrations are required, the leakage factor is usually small and does not restrict the nuclear polarization whose magnitude may be larger than that theoretically attainable in other DNP methods. Another advantage of the method is the high rate of variation of the polarization sign; a shortcoming is the necessity of using higher uhf power than in the usual DNP method. (auth)

14918 THEORY OF GAMMA RAY DIFFRACTION ON CRYSTALS CONTAINING MOESSBAUER NUCLEI AT LATTICE SITES WITH A NONUNIFORM ELECTRIC FIELD. Aivazian, Yu. M.; Belyakov, V. A. Zh. Eksp. Teor. Fiz., 56: 346-54(Jan. 1969). russian).

A kinematic theory of diffraction is developed for the case of nuclear resonance scattering γ quanta on crystals containing Moessbauer nuclei at lattice sites with a nonuniform electric field. Expressions for the amplitude of scattering on single nuclei, for the cross section of coherent scattering on the crystal, and polarization of radiation at Bragg maxima are obtained for the case of quadrupole splitting of nuclear levels of the Moessbauer nuclei. Conditions of applicability of the formulas for describing diffraction on real crystals are discussed. It is shown that Moessbauer diffraction may be an efficient method for investigating ferroelectric structures in which the Moessbauer nuclei are located at several, crystallographically almost equivalent, sites. (auth)

14919 PARAMAGNETIC SUSCEPTIBILITY OF YTTRIUM AND RHENIUM SINGLE CRYSTALS. Volkenshtein, N. V.; Galoshina, E. V.; Shchegolikhina, N. I. (Inst. of Physics of Metals, Moscow). Zh. Eksp. Teor. Fiz., 56: 139-43(Jan. 1969). (In Russian).

The temperature dependence of the paramagnetic susceptibility of yttrium and rhenium single crystals is investigated for two directions of the field relative to the hexagonal axis: $c \parallel H$ and $c \perp H$ at temperatures from 20.4 to 293°K. It is found that in both metals $\chi_\perp > \chi_\parallel$. The orbital contribution to the susceptibility is estimated by comparing χ_{meas} with χ calculated on basis of the band theory. In the metals investigated, the temperature dependence coefficient $d\chi/dT > 0$. Possible causes of the observed temperature dependen are discussed. (auth)

14920 GALVANOMAGNETIC PHENOMENA IN THIN FILMS OF SOME TRANSITION METALS. Panchenko, O. A.; Lutsishin, P. P.; Ptushinskii, Yu. G. (Inst. of Physics, Kiev). Zh. Eksp. Teor. Fiz., 56: 134-8(Jan. 1969). (In Russian).

The electric conductivity and Hall constants of thin films of transition metals Cr, W, Pd, and Pt, vaporized under high vacuum conditions were measured. The results were interpreted under the assumption of a two-band mechanism of electric current flow. Data on the electron and hole mean free paths in films of the metals were obtained. (auth)

14921 OPTICAL PROPERTIES OF NIOBIUM. Golovashkin, A. I.; Leksina, I. E.; Motulevich, G. P.; Shubin, A. A. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz., 56: 51-64(Jan. 1969). (In Russian).

The optical constants n and κ ($n - i\kappa$ is the complex refractive index) of electropolished Nb of an electron beam melt of 99.9% purity are measured in the 0.4- to 10 micron spectral range at helium, nitrogen, and room temperatures. Special x-ray diffraction and optical investigations were performed which made it possible to prepare the samples without cold hardening and without an oxide film. The main characteristics of the conductivity electrons of Nb (conductivity electron concentration N, mean electron velocity on Fermi surface v_F, total area of Fermi surface S_F, effective electron collision frequency ν) and their temperature dependence are derived on basis of the data on n and κ in the infrared region of the spectrum. Fourier components of the pseudopotential V_g are derived from measurements in the visible and near infrared regions of the spectrum. The values of V_g are employed for determining the conductivity electron concentration N; the value is the same as that derived from the measurements in the infrared region of the spectrum. Equality of the two values indicates that the weak coupling approximation is valid for describing the optical properties of Nb. (auth)

14922 USE OF NEUTRON DIFFRACTION IN THE STUDY OF THE PROPERTIES OF MATTER. Legrand, E. (Centre d'Etude de l'Energie Nuclear, Mol, Belg.). pp 46-61 of Application of Advanced and Nuclear Physics to Testing Materials. Special Technical Publication No. 373. Philadelphia, American Society for Testing and Materials, 1965. (BLG-403).

In recent years neutron diffraction became an important tool in the study of the properties of matter. In structure research it is used to complete the information of x-ray diffraction measurements. To illustrate this, some examples are given of recent investigations on carbides, cyanides, and oxides of heavier elements, where the neutron measurements have allowed either to determine the positions of the light atoms or to correct or refine earlier x-ray measurements. Neutrons have also been used in the study of the physical structure of materials. In this connection, some measurements on preferential orientation and grain size are described. However, the study of magnetic structures is perhaps the most specific topic for neutron-diffraction techniques. It is mainly in this field that measurements have been made at the Mol laboratory. Some experiments on perovskite-like compounds are described. (auth)

14923 SHAPES OF INHOMOGENEOUSLY BROADENED RESONANCE LINES IN SOLIDS. Stoneham, A. M. (Atomic Energy Research Establishment, Harwell, Eng.). Rev. Mod. Phys., 41: 82-108(Jan. 1969).

Inhomogeneous broadening has been observed in resonance lines in solids over the wide range of energies spanned by nuclear magnetic resonance, electron spin resonance, optical, and Mössbauer methods. The broadening arises from random strains, electric fields, and other perturbations from the defects in the lattice containing the center whose transitions are studied. This paper reviews the calculation of the shapes of such resonance lines. The most important method used is the so-called statistical method. This method determines the line shape as a function of the distribution of the defects with respect to the centres studied, the density of the defects, and the perturbation fields of the individual defects. Emphasis is laid on the physical assumptions and approximations in this method and on its relation to other approaches. The theory is applied to a variety of broadening mechanisms, both in the widely used continuum approximation for the lattice containing the defects and in the more realistic discrete-lattice model. Two classes of experimental work are reviewed. The first deals with the ways in which resonance lines are recognized as being inhomogeneously broadened. These methods show that a wide range of phenomena can be used to check the theory of the line shapes. The second discussion of the experimental work compares theory and experiment for each of the various broadening mechanisms. These mechanisms include broadening by the strains from dislocations and point defects, by the electric fields and field gradients from charged defects, and by unresolved hyperfine structure. In each case theory and experiment are compared in detail for the system for which the most complete data are available. The conclusion is that the statistical method provides a satisfactory approach in all cases for which there are adequate data. (auth)

Theoretical Physics

Refer also to abstracts 14733, 15217, and 15348.

14924 DYNAMICAL SYMMETRY OF RELATIVISTIC CHARGED PARTICLE IN CONSTANT MAGNETIC FIELD. Malkin, I. A.; Manko, V. I. (Moscow Physical-Technical Inst.). Yadern. Fiz., 8: 1264-72(Dec. 1968). (In Russian).

It is shown that the space of states of a charged particle with spin $\frac{1}{2}$ in the constant homogeneous magnetic field at fixed momentum along the direction of the field is the space of infinite-dimensional irreducible representation of the noncompact group U(2,1). The group U(1,1) is the invariance group of this problem. Analogous results are obtained for a particle with zero spin. (auth)

14925 SOLUTION OF SCHROEDINGER EQUATION FOR HELIUM AND HELIUM-LIKE ATOMS IN NEW SELECTION OF COORDINATE SYSTEM. Dombrovski, L. (Inst. of Physics, Sofia). Compt. Rend. Acad. Bulg. Sci., 21: 203-6(1968). (In Russian).

An orthogonal transformation of independent variables was used for numerical solutions. The transition to the new variables was achieved by function $r_1 = r \cos \alpha$, $r_2 = \sin \alpha$, $\theta_1 = \theta_1$, $\theta_2 = \theta_2$, $\varphi_1 = \varphi$, and $\varphi_2 = \varphi_2$. The Schroedinger equation was written in nonrelativistic approximation without considering spin–orbital interactions. The written-out system of eigenvalue functions for the unperturbed Hamiltonian is a complete and orthogonal system and can be used as a basis. (R.V.J.)

14926 HIGHER CORRECTIONS TO THE WKB APPROXIMATION. Van Kampen, N. G. (Rijksuniversiteit, Utrecht). Physica, 35: 70-9(1967).

A systematic method of successive approximations is described, of which the first step is the WKB approximation. The higher corrections consist of successive recombinations of the two WKB waves, rather than a perturbation expansion in their interaction. At the same time the local wave number (or refractive index) undergoes successive corrections. Using this method it is shown that the quantum-mechanical reflection by a potential barrier is a small quantity of order $\hbar^{\infty}$, provided that the barrier is smooth, and so low that there is no classical turning point. (auth)

14927 APPLICATION OF THE METHODS OF FIELD THEORY TO MOLECULAR PHYSICS. Lindenberg, Jan (Univ. of Aarhus, Denmark). Magy. Fiz. Foly., 16: 469-99(1968). (In Hungarian).

The paper represents an extension of a course professed at the International Summer School for Quantum Chemistry organized by the Hungarian Academy of Sciences. It covers the field theory methods applied for solving the many body problem in quantum mechanics, such as second quantification and propagators in molecular physics. After introducing the fermion operators, the concept of electron propagators and Green functions is clarified, using a formal solution of the Schrödinger equation. The spectral properties of Green functions are then outlined, discussing the new theory of atomic and molecular tracks and defining the vertex function. The semi-empirical approximation methods of quantum chemistry are examined on the basis of the effective Hamiltonian operator. An attempt was made to establish a relationship between the classical treatment and the new method, indicating the potential applications of the latter. The goal of the paper is to facilitate study of the original literature in this area. (Review article, 48 references). (TTT)

14928 COUNTEREXAMPLE TO THE TANGHERLINI ARGUMENT. Rindler, W. (Southwest Center for Advanced Studies, Dallas). Amer. J. Phys., 37: 72-3(Jan. 1969).

Tangherlini has stated a set of postulates which lead to Schwarzschild's metric without the use of field equations. These postulates are shown to be inconsistent when applied to the parallel vacuum field. (auth)

14929 TRANSLATION-INVARIANT QUASI-FREE STATES AND BOGOLYUBOV TRANSFORMATIONS. Rocca, Francois; Sirugue, Michel; Testard, Daniel (CNRS, Marseille). Compt. Rend., Ser. A and B, 267: 722-3(Nov. 4, 1968). (In French).

Results are given relative to the action of Bogolyubov transformations on the translation invariant quasi-free states of the fermion field. (tr-auth)

14930 PROBLEMS AND SOLUTIONS IN MATHEMATICAL PHYSICS. Choquet-Bruhat, Y. Holden-Day Series in Mathematical Physics. San Francisco, Holden-Day, Inc., 1967. 327p. $10.75.

Translated by C. Peltzer.

Problems and worked out solutions for linear algebra and analysis and for function spaces and differential and integral operators are presented. The problems are drawn from classical and modern physics. Linear algebra, matrices, tensors, exterior differential forms, differential geometry, Hilbert space, integral equations, and ordinary and partial differential equations are covered. (C.E.S.)

14931 PATH INTEGRAL FOR SPIN. Schulman, Lawrence (Indiana Univ., Bloomington). Phys. Rev., 176: 1558-69(Dec. 25, 1968).

A path integral for spinning particles is developed. It is a one-particle theory, equivalent to the usual quantum mechanics. Our method employs a classical model for spin which is quantized by path integration. The model, the spherical top, is a natural one from a group-theoretic point of view and has been used before in a similar context. The curvature and multiple connectedness of the top coordinate space [SO(3)] provide some interesting features in the sum over paths. The Green's function which results from this procedure propagates all spins, and recovery of the usual Pauli spinors from this formalism is achieved by projection to a specific spin subspace. (auth)

14932 QUANTUM THEORY OF AN ELECTRON GAS WITH ANOMALOUS MAGNETIC MOMENTS IN INTENSE MAGNETIC FIELDS. Chiu, Hong-yee (Goddard Space Flight Center, New York); Canuto, Vittorio; Fassio-Canuto, Laura. Phys. Rev., 176: 1438-42(Dec. 25, 1968).

An investigation of the properties of an electron gas in intense magnetic fields is continued. Expressions are obtained for the thermodynamic energy density, particle density, the magnetic moment, and pair density (created in equilibrium with the system) for a gas of electrons with an anomalous magnetic moment, using the exact eigenvalues of the Dirac–Pauli equation for an electron with an anomalous magnetic moment, obtained by Ternov et al. According to the solution of Ternov et al., the lowest energy states of the electrons can be zero at certain field strengths. It is shown that pair creation does not occur spontaneously at the expense of the magnetic-field energy, but only at the expense of the thermodynamic energy of other particles of the system. Exact expressions for the pair density are given. (auth)

14933 DENSITY MATRICES IN THE MANY-BODY PROBLEM. Gluck, P. (Univ. of Birmingham, Eng.). Phys. Rev., 176: 1534-40(Dec. 25, 1968).

The problem of correlations is considered in many-fermion systems, although with some modifications the methods are more general. The many-body problem is formulated in terms of reduced one- and two-particle density matrices, and the equations for these are treated by variational and iterative methods. The formalism is applied to a calculation of the energy per particle for a system interacting with Coulomb, screened Coulomb, and singular potentials. Comparisons with the ideas of Brueckner and others are made, and difficulties are discussed. (auth)

14934 MOMENTUM OPERATORS IN QUANTUM MECHANICS. Arthurs, A. M. (Univ. of York, Eng.). Proc. Nat. Acad. Sci. U. S., 60: 1105-9(Aug. 15, 1968).

A representation for real functions of the momentum operator P has been obtained by using functional integration in phase space. The resulting operators are self-adjoint on the interval $[\alpha,\beta]$ of the real line. For the operator P itself, the representation involves the first derivative of the delta function. This work has dealt solely with Cartesian coordinates. (C.E.S.)

14935 HOW GOOD IS THE BORN-OPPENHEIMER APPROXIMATION? Moshinsky, M.; Kittel, C. (Univ., Mexico, Mexico City. Univ. of California, Berkeley). Proc. Nat. Acad. Sci. U. S., 60: 1110-13(Aug. 1968).

The example of two massive particles interacting through harmonic oscillation potentials both between themselves and with a light particle, which can be solved exactly, is used for a critical analysis of the Born–Oppenheimer approximation. (C.E.S.)

14936 ON THE CHARGED-PARTICLE LEVINSON THEOREM. Rein, Dieter (Univ., Wuerzburg, Ger.). Z. Phys., 220: 394-400(1969). (In German).

An alternative proof of the charged-particle Levinson theorem, using only the asymptotic behavior of the wave function and a continuity property for zero energy, is given. (auth)

14937 QUANTUM-STATISTICAL THEORY OF IRREVERSIBLE PROCESSES. II. THE CHARACTER OF CLOSED MACROSCOPIC LAWS. Sewell, G. L. (Queen Mary Coll., London). Physica, 34: 493-514(1967).

The dynamics of a set of macroscopic variables of a system is formulated by means of a quantum-statistical treatment that provides microscopic conditions for which the variables evolve according to a closed phenomenological law. The theory follows an approach delineated in an earlier paper (Physica, 31: 1520 (1965)), in which an exact generalized master equation for macroscopic variables was first reduced to a Markovian form and then treated so as to yield deterministic phenomenological equations. This approach is now systematized by a reformulation that provides conditions for the validity of the procedure from a generalized master equation to a deterministic law. Thus the macroscopic observables are now formulated in a scheme where some of their characteristic properties, stemming from their many-particle structures, are incorporated into the general "phase cell" repre-

sentation of Van Kampen and Emch. These properties are expressed in terms of parameters representing characteristic values of the variables of the theory. Of particular importance is a dimensionless size parameter, Γ, defined as a characteristic ratio of a macroscopic variable to a microscopic quantum. The incorporation of these characteristic properties into Emch's generalized master equation yields conditions under which a specified set of macroscopic variables conforms to a closed phenomenological law, to lowest order in Γ^{-1}. Higher order corrections represent "memory effects" and fluctuations. (auth)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

Refer also to abstracts 14999 and 15015.

Electromagnetic

Refer also to abstracts 15300 and 15498.

14938 PHENOMENOLOGICAL ANALYSIS OF PHOTOPRODUCTION OF CHARGED PIONS ON NUCLEONS IN THE NEAR-THRESHOLD ENERGY REGION. Adamovich, M. I.; Larionova, V. G.; Kharlamov, S. P.; Yagudina, F. R. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz., 8: 1181-90(Dec. 1968). (In Russian).

Energy dependence of the electric dipole amplitude E_{0+} and of the combination of p-wave amplitudes $\Delta = (M_{1+} - M_{1-} + 3E_{1+})$ for π^+ and π^- mesons is determined from experimental data. Isotopic components $E_{0+}^{(0)}$, $E_{0+}^{(-)}$, $\Delta^{(0)}$, and $\Delta^{(-)}$ are obtained. The quantity $(2M_{1+} + M_{1-})$ at two values of the photon energy E_γ = 210 MeV and 225 MeV is determined from experiments with linearly polarized photons. The πN interaction constant and the difference of the s-lengths of πN scattering in states with isospins $1/2$ and $3/2$ are estimated from the threshold values of the amplitudes $E_{0+}(\pi^+)$ and $E_{0+}(\pi^-)$. The latter are discussed together with the estimates obtained from the πN scattering. (auth)

14939 EXPERIMENTAL TESTS OF CASCADE THEORY AT HIGH ENERGIES. Holynski, R. (Louisiana State Univ., Baton Rouge); Jones, W. V.; Pinkau, K. Phys. Rev., 176: 1661-73 (Dec. 25, 1968).

Results of simultaneous measurement of the radial position and angular orientation of electrons in ten high-energy (180–2000-BeV) electromagnetic cascades are given. Six of these cascades were developed in pure emulsion, while four were developed in a lead-emulsion sandwich stack. Numerical calculations of the angular distributions, both within approximation B and the core approximation, are presented. Calculations on the mixed radial-angular distribution are related to the separate distributions. A method is given for the use of the mixed distribution to extend the effective radial range of measurement to such an extent that the transition of the experimental results from the core approximation to approximation B becomes evident. Limited experimental verification of the often-used approximation B is thereby established. It is further shown that cascade theory is internally consistent within the region of validity of the core approximation and that the radial range must extend up to $\sim 10^{-1}$ radiation length in order to include all particles having angles as small as ~4–5 deg. (auth)

14940 RELATIVISTIC ENERGY LOSS BY IONIZATION IN NUCLEAR EMULSIONS. Congel, F. J.; McNulty, P. J. (Clarkson Coll. of Tech., Potsdam, N. Y.). Phys. Rev., 176: 1615-20 (Dec. 25, 1968).

The variation in grain density in the tracks of 5-, 8-, 12-, and 24-GeV/c protons and 5-GeV/c pions has been investigated as a function of velocity in the same plate of an Ilford K-5 nuclear emulsion. About 80,000 blobs were counted for each beam. The pion-to-proton ratio of grain densities at 5 GeV/c is 1.114 ± 0.006. The results are in agreement with the Sternheimer formula using a mean ionization potential for AgBr of 434 eV and a cutoff energy T_0 of 2–5 keV. Comparison of these data with an earlier experiment in a G-5 emulsion shows no dependence of the rate of the relativistic rise in grain density on type of emulsion. The combined data from the two experiments are in excellent agreement with Sternheimer's formula with I = 434 eV and T_0 = 5 keV with no correction due to secondary ionization. A correction for secondary ionization corresponding to a 10% contribution due to secondary ionization at minimum ionization gives excellent agreement with I = 434 eV and T_0 = 2 keV. (auth)

14941 SEARCH FOR THE CONTRIBUTION OF THE LONGITUDINAL VIRTUAL PHOTON IN INELASTIC ELECTRON–PROTON SCATTERING. Bounin, Paul (CEN, Saclay, France). Phys. Rev., 176: 1643-7(Dec. 25, 1968).

A systematic investigation was made of the inelastic scattering cross section for electrons on hydrogen, keeping constant the two relativistic parameters: four-momentum transfer q^2 and equivalent photon energy K. In the one-photon-exchange approximation, it is then possible to separate the contributions due to the longitudinal and transverse virtual photon. The new feature of our experiment was the use of a thin (12-mm) flat hydrogen target. For the choice of the parameters [q^2 = 0.2, 0.3, and 0.4 $(BeV/c)^2$; K = 340 MeV] no discernible contribution of the longitudinal virtual photon was found. (auth)

14942 SEARCH FOR THE ELECTROPRODUCTION OF THE N' (1470) RESONANCE FROM DEUTERIUM. Alberi, J. L.; Appel, J. A.; Budnitz, R. J.; Chen, J.; Dunning, J. R. Jr.; Goltein, M.; Hanson, K.; Imrie, D. C.; Mistretta, C. A.; Wilson, Richard (Harvard Univ., Cambridge, Mass.). Phys. Rev., 176: 1631-4 (Dec. 25, 1968).

The energy spectrum of electrons inelastically scattered at 20° lab from deuterium was measured for an incident electron energy of 1578 MeV. The virtual photon cross section has two peaks at mass values corresponding to the Δ(1236) and N'(1525) resonances. No peak was observed in the mass region of the N'(1470) Roper resonance. The upper limit for the contribution of the Roper resonance to the virtual photon cross section is estimated to be 120 μb. (auth)

14943 SINGLE-NEGATIVE-PION PHOTOPRODUCTION ON DEUTERIUM IN THE ENERGY RANGE 500 TO 800 MeV. PRELIMINARY INVESTIGATION. Beneventano, M.; de Notaristefani, F.; Monacelli, P.; Paoluzi, L.; Sebastiani, F.; Severi, M. (Univ., Rome. Istituto Nazionale di Fisica Nucleare, Rome). Nuovo Cim., Lett., 1: 113-18(Jan. 11, 1969).

The experimental equipment and method for determining the absolute differential cross section for single π^- production in $\gamma + d \rightarrow \pi^- + p + p$ interactions at 500 to 800 MeV are described. Results are given. (W.H.K.)

14944 INTERACTIONS OF BREMSSTRAHLUNG γ-QUANTA WITH MAXIMUM ENERGY UP TO 1 GeV WITH THE COMPLEX NUCLEI. Bobrina, V. M.; Mameev, V. V.; Filimonov, V. A. (Tomsk Polytechnical Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 10, 125-9(1968). (In Russian).

The spallation of nuclei of the BR-2 photoemulsion by bremsstrahlung of the Tomsk Polytechnical Inst. synchrotron in the range of energies of accelerated electrons from 400 to 1000 MeV was investigated. The cross sections for formation of photostars with different numbers of prongs were obtained. For stars with prongs $N \geq 2$ the cross sections in the energy range investigated were approximately constant and equal to $(220 \pm 40) \times 10^{-30}$ cm^2 per nucleon. The measured cross sections were compared with cross sections calculated using models for photoproduction of π mesons on nucleons with their subsequent absorption in the nucleus. (tr-auth)

14945 ANGULAR AND ENERGY DISTRIBUTION OF γ QUANTA IN THE COMPTON EFFECT ON RELATIVISTIC ELECTRONS. Kulikov, O. F.; Telnov, Yu. Ya.; Filippov, E. I.; Yakimenko, M. N. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz., 56: 115-21(Jan. 1969). (In Russian).

The angular and energy distributions of γ-quanta produced in head-on collisions between a beam of linear polarized photons from a ruby laser and 550 MeV relativistic electrons are measured. The results are in good agreement with the theoretical calculations in which betatron oscillations of electrons in the accelerator are taken into account. (auth)

14946 COMPARISON OF ORSAY RESULTS ON VECTOR MESONS WITH THE VECTOR MESON DOMINANCE MODEL PREDICTIONS. Augustin, J. E.; Benaksas, D.; Bizot, J. C.; (and others) (Ecole Normale Superieure, Orsay, France). Phys. Lett., 28B: 503-7(Jan. 20, 1969).

Results of the three Orsay experiments are analyzed in the vector meson dominance hypothesis. The coupling constants of ρ^0, ω^0 and ϕ^0 mesons to the photons are determined, and the mixing angle θ_V and θ_N of the ω^0 and ϕ^0 mesons are calculated. Our values are compared to various theoretical predictions. (auth)

14947 STUDY OF ELECTRON–POSITRON ANNIHILATION INTO $\pi^+\pi^-$ ON THE ρ^0 RESONANCE. Augustin, J. E.; Bizot, J. C.; Buon, J.; (and others) (Ecole Normale Superieure, Orsay, France). Phys. Lett., 28B: 508-12(Jan. 20, 1969).

The electromagnetic form factor of the pion was determined in the ρ^0 resonance region by measuring the absolute cross section of the reaction $e^+ + e^- \rightarrow \pi^+ + \pi^-$ with the Orsay storage ring. More than 800 pion pairs were detected. The excitation curve was fitted with a Breit–Wigner formula which leads to the following values: $\sigma_{peak} = (1.69 \pm 0.21)\ 10^{-30}$ cm^2; $m_\rho = (770 \pm 4)$ MeV; $\Gamma_\rho = (111 \pm 6)$ MeV. The partial width of the ρ^0 going into e^+e^- thus obtained is: $\Gamma_\rho \rightarrow e^+e^- = (7.36 \pm 0.7)$ keV. (auth)

14948 ω^0 PRODUCTION BY e^+e^- ANNIHILATION. Augustin, J. E.; Benaksas, D.; Buon, J.; (and others) (Ecole Normale Superieure, Orsay, France). Phys. Lett., 28B: 513-16(Jan. 20, 1969).

The reaction $e^+e^- \rightarrow \omega^0$ was measured by detecting the charged pions of the $\pi^+\pi^-\pi^0$ decay mode of the ω^0. A partial decay width of ω^0 in e^+e^-: $\Gamma_{e^+e^-} = 0.94 \pm 0.18$ keV is deduced from this result. (auth)

14949 STUDY OF THE ϕ MESON PRODUCTION WITH THE ORSAY ELECTRON–POSITRON COLLIDING BEAMS. Augustin, J. E.; Bizot, J.; Buon, J.; (and others) (Ecole Normale Superieure, Orsay, France). Phys. Lett., 28B: 517-20(Jan. 20, 1969).

The $e^+e^- \rightarrow \phi$ reaction was measured by the $K_S^0K_L^0$ and 3π decay modes of the ϕ. $\Gamma(\phi \rightarrow$ all), $\Gamma(\phi \rightarrow e^+e^-)$, as well as $B(\phi \rightarrow K_S^0K_L^0)$, $B(\phi \rightarrow K_S^+K_L^-)$ and $B(\phi \rightarrow \pi^+\pi^-\pi^0)$, were deduced. (auth)

14950 ANGULAR DISTRIBUTION OF DEUTERON PHOTODISINTEGRATION BETWEEN 240 AND 320 MeV. Sober, D. I. (Cornell Univ., Ithaca, N. Y.); Cassel, D. G.; Sadoff, A. J.; Chen, K. W.; Crean, P. A. Phys. Rev. Lett., 22: 430-3(Mar. 3, 1969).

The angular distribution of deuteron photodisintegration has been measured at laboratory photon energies from 240 to 320 MeV in a spark chamber experiment at the Cornell 2-GeV synchrotron. The angular dependence of the cross section is consistent with other recent measurements. A comparison with data on the inverse reaction, $n + p \rightarrow d + \gamma$, should provide a meaningful test of time-reversal invariance in electromagnetic interactions of hadrons. (auth)

14951 HIGH-ENERGY PHOTOPRODUCTION OF ρ^0 MESONS FROM HYDROGEN AND DEUTERIUM. McClellan, G. (Cornell Univ., Ithaca, N. Y.); Mistry, N.; Mostek, P.; Ogren, H.; Silverman, A.; Swartz, J.; Talman, R.; Gotifried, K.; Lebedev, A. I. Phys. Rev. Lett., 22: 374-7(Feb. 24, 1969).

The photoproduction of ρ^0 mesons from hydrogen and deuterium was measured as a function of the photon energy and the square of the momentum transfer. The assumption that the ρ is produced by a purely diffractive mechanism is mildly contradicted by the data. (auth)

14952 PHOTOPRODUCTION OF ρ^0 MESONS FROM COMPLEX NUCLEI. McClellan, G.; Mistry, N.; Mostek, P.; Ogren, H.; Silverman, A.; Swartz, J.; Talman, R. (Cornell Univ., Ithaca, N. Y.). Phys. Rev. Lett., 22: 377-82(Feb. 24, 1969).

The photoproduction of ρ^0 mesons from several complex nuclei was measured. Good agreement with a diffraction model is obtained, and comparison is made with the vector-dominance model. If one writes the ρ-photon coupling constant as $em_\rho^2/2\gamma_\rho$ it is found that $\gamma_\rho^2/4_\pi = 1.10 \pm 0.15$. (auth)

14953 WIDE-ANGLE BREMSSTRAHLUNG. Siemann, R. H.; Ash, W. W.; Berkelman, K.; Hartill, D. L.; Lichtenstein, C. A.; Littauer, R. M. (Cornell Univ., Ithaca, N. Y.). Phys. Rev. Lett., 22: 421-4(Mar. 3, 1969).

The bremsstrahlung yield was measured at 6.2° in the reaction $e^- + C \rightarrow e^- + C + \gamma$ using incident-electron energies up to 9.5 GeV. The data confirm the predictions of quantum electrodynamics for timelike electron four-momenta up to 1 GeV. (auth)

14954 PION ELECTROPRODUCTION CROSS-SECTION NEAR THRESHOLD. Balla, M. (Univ., Pisa, Italy. Istituto Nazionale di Fisica Nucleare, Pisa, Italy); Di Giorgio, G. V.; Giazotto, A.; Giorgi, M.; Serbassi, S.; Stoppini, G.; Amaldi, E.; Borgia, B.; Pistilli, P. Nuovo Cim., Lett., 1: 247-51(Feb. 1, 1969).

Some preliminary results obtained from a partial analysis of data collected in a coincidence experiment on electroproduction of pions near threshold. The reactions are $e + p \rightarrow e' + n + \pi^+$ and $e + p \rightarrow e' + p + \pi^0$. The aim of the complete experiment is to isolate the cross section of the first reaction by observing the electrons scattered inelastically which are not accompanied by the emission of one proton due either to the second reaction or the reaction $e + p \rightarrow e' + p + \gamma$. (J.F.P.)

14955 TOTAL CROSS-SECTION FOR PAIR PRODUCTION AND ITS RELATIONSHIP TO TESTS OF THE VALIDITY OF QUANTUM ELECTRODYNAMICS. Knasel, T. M. (Harvard Univ., Cambridge, Mass.). pp 549-55 of High Energy Physics and Fundamental Particles. Barut, Asim O.; Brittin, Wesley E. (eds.). New York, Gordon and Breach, Science Publishers, 1968.

A review of the experimental tests of quantum electrodynamics and a report on new experimental data on the process of pair production by a photon are presented. A summary of data for total pair production cross sections on carbon, aluminum, and copper is given. (L.B.S.)

Weak

14956 (COO-1195-153) SEARCH FOR THE DECAY OF NEUTRAL SHORT-LIVED K MESONS INTO TWO MUONS. Stutzke, Richard David (Illinois Univ., Urbana). 1969. Contract AT(11-1)-1195. 92p. Dep. CFSTI.

Thesis.

A search for the decay $K_S^0 \rightarrow \mu^+\mu^-$ was completed at the Argonne ZGS. The detection apparatus consisted of thin foil spark chambers placed in a 10 kilogauss field for momentum measurement, followed by a block of steel absorber and range spark chambers to observe the decay muons. The data were normalized using $K_S^0 \rightarrow \pi^+\pi^-$ decays obtained by removing the steel absorber. Bona fide $K_S^0 \rightarrow \pi^+\pi^-$ decays were required to have a reconstructed invariant two-pion mass between 480 MeV and 520 MeV and to have a reconstructed decay vertex located within the decay region seen by the detection apparatus. As an additional check the bona fide $K_S^0 \rightarrow \pi^+\pi^-$ decays selected in the above manner were used to compute the lifetime of the K_S^0 meson. A value of $(0.87 \pm 0.20) \times 10^{-10}$ seconds was obtained, in good agreement with the accepted value. Using the number of bona fide $K_S^0 \rightarrow \pi^+\pi^-$ decays observed in the apparatus the yield of K_S^0 mesons produced per count in the beam monitor telescope was found to be approximately $(2.0 \pm 0.2) \times 10^{-7}$ K_S^0 mesons per monitor count. This yield is in favorable agreement with the calculated value of $(1.9 \pm 0.5) \times 10^{-7}$ K_S^0 mesons per monitor count which was computed using measured K_S^0 production cross sections and the detection efficiency computed by a Monte Carlo program. No $K_S^0 \rightarrow \mu^+\mu^-$ events were found. The upper limit for the branching ratio obtained from this experiment is: $\Gamma(K_S^0 \rightarrow \mu^+\mu^-)/\Gamma(K_S^0 \rightarrow$ all decays) $\leq 1.0 \times 10^{-4}$. (auth)

14957 MUON POLARIZATION IN $K_{\mu3}^0$-MESON DECAY. Abrams, R. J.; Abashian, A.; Mischke, R. E.; Nefkens, B. M. K.; Smith, J. H.; Thatcher, R. C.; Verhey, L. J.; Wattenberg, A. (Univ. of Illinois, Urbana). Phys. Rev., 176: 1603-15(Dec. 25, 1968).

The polarization of the muon in the decay $K_L^0 \rightarrow \pi^-\mu^+\nu$ was measured in a spark-chamber experiment. For the decay phase space measured in this experiment, the results are $\alpha\bar{P}_L = 0.31 \pm 0.07$, $\alpha\bar{P}_T = -0.02 \pm 0.07$, and $\alpha\bar{P}_p = -0.10 \pm 0.07$, where $\bar{P}_L$, $\bar{P}_T$, and $\bar{P}_p$ are the average components of polarization along the muon momentum, transverse to the decay plane, and perpendicular to the muon in the decay plane. The analyzing parameter α of the muon decay is about 0.35 in this experiment. From the above polarization results, assuming energy-independent form factors, the ratio of form factors $\xi = f_-/f_+$ is obtained; the results are $\mathrm{Re}\xi = -1.6 \pm 0.5$ and $\mathrm{Im}\xi = -0.2 \pm 0.6$. (auth)

14958 DETERMINATION OF THE RATIO C_A/C_V BY MEASUREMENT OF THE PROTON SPECTRUM IN NEUTRON DECAY. Riehs, Peter (Physik-Institut, Seibersdorf, Austria). Acta Phys. Austr., 27: 205-11(1968). (In German).

The determination of the ratio C_A/C_V of beta decay coupling constants from neutron decay alone is considered in connection with a planned experiment. It appears most promising to determine the angular correlation between electron and antineutrino from the slope of the proton recoil spectrum, without coincidence requirement. The deformation of the spectrum due to the thermal energies of neutrons and to the finite spectrometer resolution is estimated. (auth)

14959 CRITICAL EXAMINATION OF DIRECT MUON PRODUCTION. Sheldon, W. R. (Univ. of Houston, Tex.); Cantrell, W. G.; Duller, N. M. Phys. Rev. Lett., 22: 312-15(Feb. 17, 1969).

The muon range-energy relation indicated by experimental results of the Utah neutrino detector is presented. Difficulties arising from the observed isotropy in the muon flux are discussed. (auth)

14960 DECAY OF LONG-LIVED NEUTRAL KAONS INTO TWO NEUTRAL PIONS. Gaillard, J.-M. (CERN, Geneva); Galbraith, W.; Hussri, A.; Jane, M. R.; Lipman, N. H.; Manning, G.; Ratcliffe, T. J.; Faissner, H.; Reithler, H. Nuovo Cim., 59A: 453-89(Feb. 21, 1969).

A final result is presented for a measurement of the $K_L^0 \rightarrow 2\pi^0$ decay rate. A detailed description of the experiment and its analysis is given. The value of $|\eta_{00}| = (3.6 \pm 0.6) \cdot 10^{-3}$ differs by approximately 3 standard deviations from $|\eta_+| = (1.89 \pm 0.09) \cdot 10^{-3}$. The theoretical implications of the result are discussed. (auth)

Strong (Baryon-Induced)

Refer also to abstract 15494.

14961 (CERN-Trans-68-9) POLARISATION EXPERIMENTS TO TEST T- AND CPT-INVARIANCE IN NUCLEON-NUCLEON AND NUCLEON-ANTINUCLEON SCATTERING. Bilenskii, S. M.; Lapidus, L. I.; Ryndin, R. M. (Joint Inst. for Nuclear Research, Dubna (USSR)). Translated by B. Hodge and revised by N. Mouravieff (European Organization for Nuclear Research, Geneva, Switzerland), from report JINR-P2-3716. 16p. Dep.

Experiments to test T invariance in elastic proton-proton scattering are discussed. Also a brief study is made of the possible experiments for testing CPT invariance during elastic scattering of antiprotons by protons. (J.F.P.)

14962 ANGULAR CORRELATIONS AND DISTRIBUTIONS IN $\bar{p}p$ ANNIHILATION INTO EIGHT AND NINE PIONS AT 5.7 GeV/c. Fridman, A. (Centre de Recherches Nucleaires, Strasbourg. Univ., Heidelberg); Maurer, G.; Michalon, A.; Oudet. J.; Strub, R.; Voltolini, C.; Cueer, P. Phys. Rev., 176: 1595-1602(Dec. 25, 1968).

Appreciable angular correlations between pions have been observed for both $\bar{p} + p \rightarrow 4\pi^+ + 4\pi^-$ and $\bar{p} + p \rightarrow 4\pi^+ + 4\pi^- + \pi^0$ reactions. Deviation between the angular correlation predicted by the phase-space calculations and our experimental values seems to occur for definite-momentum configurations of the produced pions. The secondaries are not emitted in a jet structure, i.e., the transverse and c.m. longitudinal momentum of the pions are in satisfactory agreement with phase predictions. By comparing the results of this experiment with other $\bar{p}p$ data, some systematics seem to emerge for the angular distribution of secondary pions. (auth)

14963 EVIDENCE FOR THE EXISTENCE OF A NARROW $\eta^0\pi^\pm$ RESONANCE AT 975 MeV, INTERPRETED AS A DECAY OF THE $\delta^\pm$ MESON, AND EVIDENCE FOR A $\delta^\pm\pi^\mp$ DECAY OF THE D^0 MESON. Defoix, C. (College de France, Paris); Rivet, P.; Siaud, J.; Conforto, B.; Widgoff, M.; Shively, F. Phys. Lett., 28B: 353-5(Dec. 23, 1968).

Two peaks are observed in $\eta^0\pi^\pm$ and $\eta^0\pi^+\pi^-$ effective mass distributions near 975 MeV and 1310 MeV respectively, in events fitting the reaction $\bar{p}p \rightarrow 3\pi^+3\pi^-\pi^0$. The narrow $\eta^0\pi^\pm$ peak is interpreted as a new evidence for the existence of the $\delta^\pm$ meson. The second peak is strongly correlated to the first one and is interpreted as evidence for the decay $D^0 \rightarrow \delta^\pm\pi^\mp$. (auth)

14964 NATURE OF THE PRIMARIES OF HORIZONTAL AIR SHOWERS. Sitte, K. (Univ., Turin. Univ., Freiburg i. B.). Nuovo Cim., Lett., 1: 252-5(Feb. 1, 1969).

Recent experiments have revealed the existence of near-horizontal air showers at a rate much in excess of that expected for nucleonic primaries. In some of these events nuclear interactions and penetrating particles could be identified. An attempt is made to relate these data with the results of two other experiments recently reported, which if confirmed would gravely affect the picture of high energy interactions. (J.F.P.)

14965 Λ BINDING ENERGY IN LIGHT HYPERFRAGMENTS ($A \leq 16$). Bhowmik, B.; Chand, T.; Chopra, D. V. (Univ. of Delhi). Nuovo Cim., 59A: 309-14(Feb. 1, 1969).

A binding energy values of 103 uniquely identified mesonic hyperfragments, produced by the interactions of K^--mesons at rest and at momentum 1.5 GeV/c with emulsion nuclei, are presented. One of the events is a ${}^{7}_{\Lambda}Be$ with $B_\Lambda = (4.93 \pm 0.55)$ MeV. (auth)

14966 PION PRODUCTION IN PROTON-PROTON INTERACTIONS AT 6.6 GeV/c. Colton, Eugene Paul. Los Angeles, Univ. of California, 1968. 213p.

Thesis.

A study was made of proton-proton collisions resulting in reactions of the type proton + proton → nucleon + nucleon + $m\pi$, where m = 0,1,2, and 3. The interactions were photographed in the LRL's 72-inch liquid hydrogen bubble chamber which was exposed to a 6.6 GeV/c separated external proton beam. Two production topologies were analyzed. The two-prong events with no kinking secondaries yielded the reactions (1) $p + p \rightarrow p + p$, (2) $p + p \rightarrow p + p + \pi^0$, (3) $p + p \rightarrow p + n + \pi^+$, and the four-prong events yielded the reactions (4) $p + p \rightarrow p + p + \pi^+ + \pi^-$, (5) $p + p \rightarrow p + p + \pi^+ + \pi^- + \pi^0$, and (6) $p + p \rightarrow p + n + \pi^+ + \pi^+ + \pi^-$. At 6.6 GeV/c the production cross sections for reactions (1) through (6) are, respectively, 10.2 ± 0.5 mb, 2.06 ± 0.19 mb, 4.89 ± 0.28 mb, 2.70 ± 0.16 mb, 2.15 ± 0.13 mb, and 2.47 ± 0.15 mb. For the elastic scattering hypothesis (1) the differential cross section $d\sigma/dt$ is displayed. The data are consistent with an exponential t dependence of the form e^{-at} which is predicted by a simple optical model of diffraction scattering with no spin dependence. For both of the three-body final states the invariant mass, Chew-Low and Dalitz plots are presented. The data, in each case, are inconsistent with the predictions of Lorentz-invariant isotropic three-body phase space. In particular, the nucleon center of mass angular distributions is extremely peaked in the forward and backward hemispheres suggesting a peripheral one-particle-exchange mechanism. The data for reactions (2) and (3) and for the quasi-two-body intermediate state $p + p \rightarrow N^{*++}(1238) + n$ (which represents 25-30% of the $pN\pi^+$ sample) can be described quite well by the predictions of simple one-pion-exchange (OPE) models modified by suitable form factors. Eighty percent of the events which form the sample for reaction (4) proceed through the quasi-three-body state $p + p \rightarrow N^{*++}(1238) + p + \pi^-$. In the majority of these events the N^{*++} is produced peripherally. A detailed OPE calculation, using the maximum likelihood method, was carried out on a subsample of the N^{*++} events. The data are found to agree well with the predictions of the OPE diagram with $\pi^\pm p$ elastic scattering at each vertex. The observed N*(1400) effect and its relation to OPE are discussed. N^{*++} production is also observed in states leading to the five-body reactions (5) and (6) approximately 60 and 50% of the time, respectively. For the peripheral N^{*++} events, the OPE model with off-mass- shell π^-p scattering at one vertex and N^{*++} production at the other was used to determine the ratios of the off-mass-shell scattering cross sections for $\pi^-p \rightarrow \pi^-p$, $\pi^-p \rightarrow p\pi^0$, and $\pi^-p \rightarrow \pi^-\pi^+n$ as a function of t and π^-p C.M. energy. These ratios were compared with their known on-shell values and were found to agree quantitatively for low t. (Diss. Abstr.)

14967 ISOBAR PRODUCTION IN FOUR-PRONG p-p INTERACTIONS AT 22 GeV/c. Schroeder, L. S. (Iowa State Univ., Ames). pp 83-95 of High Energy Physics and Fundamental Particles. Barut, Asim O.; Brittin, Wesley E. (eds.). New York, Gordon and Breach, Science Publishers, 1968.

A bubble chamber study of $p + p \rightarrow p + p + \pi^+ + \pi^-$ and $p + p \rightarrow p + \pi^+ + \pi^+ + \pi^- + n$ interactions at 22 GeV/c is described. Effective mass distribution and resonance production data, particularly $N^{*++}(1238)$ production data, are presented. (W.H.K.)

Strong (Meson-Induced)

14968 (HUX-2752-44) BARYON RESONANCE PRODUCTION IN π^-p INTERACTIONS AT 13 GeV/c AND 20 GeV/c. Brandenburg, G. W.; Brenner, A. E.; Eisenstein, B.; (and others) (Harvard Univ., [Cambridge, Mass. Dept. of Physics]). Aug. 1968. Contract AT(30-1)-2752. 15p. (CONF-680809-43). Dep. CFSTI.

From 14th International Conference on High Energy Physics, Vienna, Austria.

The events $\pi^- + p \rightarrow p + \pi^+ + \pi^- + \pi^-$ at 13 and 20 GeV/c and $\pi^- + p \rightarrow p + \pi^+ + \pi^- + \pi^- + \pi^0$ at 20 GeV/c were studied in a bubble chamber. Mass spectra are shown for strong N^{*++} (1236) production, N* (1688) production, and an enhancement between 1.35 and 1.5 GeV/c^2. Also some ρ production is observed. The results are preliminary. (J.F.P.)

14969 (SLAC-PUB-531(Exp.)) INELASTIC PION-NUCLEON SCATTERING FROM 720 TO 1180 MeV/c. Brody, A. D.; Kernan, A. (Stanford Linear Accelerator Center, Calif.); Berge, P.; (and others) (California Univ., Berkeley. Lawrence Radiation Lab.). [1968]. 33p. (CONF-680809-44). Dep. CFSTI.

From 14th International Conference on High Energy Physics, Vienna, Austria.

Data analysis and interpretation for $\pi + N$ interactions at 720 to 1180 MeV/c are discussed. Cross sections and angular distributions are presented. (W.H.K.)

14970 EFFECT OF BACKGROUND ON THE $I = 2\pi\pi$ SCATTERING PHASE SHIFTS. Abe, K.; Johnson, A. D.; Stenger, V. J.; Wohlmut, P. G. (Univ. of Hawaii, Honolulu). Phys. Rev. Lett., 22: 251-4(Feb. 10, 1969).

It is shown that in the reaction $\pi^-p \rightarrow \pi^-\pi^-\pi^+p$ at 3.9 GeV/c, the peaking in the $\pi^-\pi^-$ scattering angular distribution above 0.6-GeV c.m. energy inferred from the one-pion exchange model can be interpreted as resulting from a background of competing processes. Similar background effects may be significant also in the reaction $\pi^+p \rightarrow \pi^+\pi^+n$, and conclusions from that reaction as to evidence for d waves in the I = 2 amplitude below 1 GeV should be reserved pending a similar analysis. (auth)

14971 $\pi^-p \rightarrow \pi^-\pi^0p$ REACTION AT 2.77 GeV/c FOR LOW MOMENTUM TRANSFERS TO THE PROTON. Baton, J. P.; Laurens, G. (CEN, Saclay, France). Phys. Rev., 176: 1574-86(Dec. 25, 1968).

The reaction $\pi^-p \rightarrow \pi^-\pi^0p$ produced by 2.77-GeV/c pions was studied for low squared four-momentum transfers to the proton ($\Delta^2 \leq 13\mu^2$). A selection based on a fast premeasurement method has allowed the accumulation of high statistics (7666 events) and a detailed study of the ρ^- properties. In particular, the ρ^- mass and width are determined as a function of Δ^2, showing essentially no variation of these parameters in the whole Δ^2 range. On the

other hand, the mass and width values deduced from the mass spectra (ω_r = 773 ± 2 MeV, Γ_r = 150 ± 5 MeV) differ from the corresponding values for the resonant P wave (ω_r = 755 ± 5 MeV, Γ_r = 110 ± 9 MeV) obtained by extrapolation to the pion pole, following the Chew–Low method. Essential results on the $\pi^-\pi^0$ elastic cross section are summarized. The sensitivity of the determination of the ρ^- production and decay parameters to various mass and Δ^2 cuts is shown. (auth)

14972 K*(890) AND K*(1420) PRODUCTION IN K⁻p INTERACTIONS AT 4.57 BeV/c. Kang, Y. W. (Ames Lab., Iowa). Phys. Rev., 176: 1587-94(Dec. 25, 1968).

A study of three-body final states produced in 2-prong K⁻p interactions at 4.57 BeV/c is presented on the basis of 10,500 GUTS-fitted events. Abundant production of K*(890) is observed in all three final states ($K^-\pi^+n$, $\pi^-p\bar{K}^0$, and $K^-p\pi^0$), while K*(1420) is more copiously produced in the final state $K^-\pi^+n$ than in the others. The spin density matrix elements for the K*(890) and K*(1420) are given and the production mechanisms are discussed in terms of the one-meson-exchange model. The cross sections for K*(890) and K*(1420) are given. (auth)

14973 CHARGE-EXCHANGE $K^- + p \rightarrow \bar{K}^0 + n$ AT 7.7 GeV/c. Buffington, A.; Frisch, D. H.; Ward, C. E. W. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Phys. Rev., 176: 1628-30(Dec. 25, 1968).

The results of a spark-chamber measurement of the reaction $K^- + p \rightarrow \bar{K}^0 + n$ at an incident kaon momentum of 7.7 GeV/c are reported. The cross section is measured to be 71 ± 13 μb. (auth)

14974 $\bar{K}^0$ AND Λ^0 PRODUCTION IN $K^- + p$ INTERACTIONS AT 7.7 GeV/c. Buffington, A.; Ward, C. E. W. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Phys. Rev., 176: 1621-8(Dec. 25, 1968).

The results are reported of a spark-chamber measurement of the reactions $K^- + p \rightarrow K^0 +$ neutrals and $K^- + p \rightarrow \Lambda^0 +$ neutrals with an incident kaon momentum of 7.7 GeV/c. The production cross sections for these reactions are measured to be 800 ± 50 μb and 188 ± 18 μb, respectively. The cross-section distributions $d^2\sigma/dP_{||}dP_\perp$ in the center-of-mass system with large momentum transfer are discussed in terms of a fireball model of production. (auth)

14975 K⁻p ELASTIC SCATTERING AT 4.6 GeV/c. Schroeder, L. S.; Leacock, R. A.; Wagstaff, R. L.; Kernan, W. J. (Ames Lab., Iowa). Phys. Rev., 176: 1648-50(Dec. 25, 1968).

K⁻p elastic scattering at 4.6 GeV/c is studied with a sample of approximately 2000 bubble chamber events. The elastic cross section is found to be σ_{el} = 4.2 ± 0.3 mb, and σ_{el}/σ_{tot} = 0.168 ± 0.017. The value of the forward differential cross section is consistent with zero real part of the scattering amplitude. No backward scattering events are observed. The Regge-pole model of Phillips and Rarita gives a reasonable fit to the data. (auth)

14976 COMPILATION OF π^-p DATA AT 4 GeV/c: BACKWARD RESONANCE PRODUCTION AND ππ SCATTERING. Johnson, P. B. (Univ. of Notre Dame, Ind.); Poirier, J. A.; Biswas, N. N.; (and others). Phys. Rev., 176: 1651-61(Dec. 25, 1968).

In π^-p single-pion-production reactions near 4 GeV/c, several interesting features are observed. Backward ρ^0 production is seen to occur with $d\sigma/du = 63 \pm 21\ \mu b/(GeV/c)^2$ at 180°. Backward ρ^- production is less prominent. Evidence is seen for production at small u of N^{*0} ($p\pi^-$ near 1700 MeV) and Δ^- ($n\pi^-$ at 1236 MeV), and possible evidence is seen for other $n\pi^-$ structure at about 1800 MeV. The density-matrix elements for peripheral ρ^0 production are presented in the Jackson and in the helicity frame. The $\pi^+\pi^-$ elastic cross section is obtained by extrapolation of the data to the mass shell. The S-wave ππ phase shifts are calculated by two methods and compared with previous results. Evidence is found in the dipion decay angular distribution for the $\pi^+\pi^-$ decay mode of the S*(1070). (auth)

14977 THE USE OF DEUTERIUM AS A TARGET FOR THE STUDY OF STRONG INTERACTIONS. Fleury, P. (Ecole Polytechnique, Paris). pp 541-68 of Methods in Subnuclear Physics. Vol. 2. Nikolic, M. (ed.). New York, Gordon and Breach, Science Publishers, Inc., 1968.

It is attempted to show to what extent the exposures on deuterium targets can be complementary to similar exposures on hydrogen. A general survey of what has been done up to now and how the data can be interpreted within the framework of the impulse approximation model is presented. The expression of the cross section for simple processes is derived with the use of this model. Experimental methods are described. (W.H.K.)

14978 ON THE 1350 MeV Λγ PEAK PRODUCED IN π^-p INTERACTION. Bozoki, G. (Central Research Inst. of Physics, Budapest); Fenyves, E.; Gemesy, T.; (and others). Phys. Lett., 28B: 360-2(Dec. 23, 1968).

The existence of the Λγ peak between 1300 and 1400 MeV was supported by our measurements. The explanation of this peak by means of the hypothetical Λη(1680 MeV) resonance can be rejected with a 97% confidence level. (auth)

14979 COHERENT K*(890) PRODUCTION OFF DEUTERIUM. Eisner, R. L.; Ammann, A. C.; Carmony, D. D.; Garfinkel, A. F.; Gutay, L. J.; Lakshmi, R. V.; Miller, D. H.; Tautfest, G. W.; Yen, W. L. (Purdue Univ., Lafayette, Ind.). Phys. Lett., 28B: 356-9 (Dec. 23, 1968).

A study was made of 76 events of the reaction $K^-d \rightarrow d\bar{K}^0\pi^-$ at 4.5 GeV/c. The reaction is dominated by the production of K*(890) and is analyzed in terms of omega exchange. The density matrix elements are obtained. (auth)

14980 $\pi^-p \rightarrow \pi^-p$ DIFFERENTIAL CROSS-SECTION AT 898 MeV/c. Bradamante, F. (Univ., Trieste, Italy. Istituto Nazionale di Fisica Nucleare, Trieste); Conetti, S.; Giorgi, M.; Penzo, A.; Piemontese, L.; Sauli, F.; Schiavon, P.; Fidecaro, G.; Fidecaro, M. Nuovo Cim., Lett., 1: 177-80(Jan. 21, 1969).

Results of a spark chamber study of the differential cross section of $\pi^- + p \rightarrow \pi^- + p$ interactions at 898 MeV/c are presented. (W.H.K.)

14981 PRODUCTION OF ^{8}Li NUCLEI IN THE INTERACTIONS OF HIGH-ENERGY K⁻ MESONS WITH NUCLEAR-EMULSION NUCLEI. Bechdolff, Alfred; Baumann, Germain; Gerber, Jean-Paul (Centre de Recherches Nucleaires, Strasbourg. Faculte des Sciences, Nancy). Compt. Rend., Ser. A and B, 267: 1039-41(Nov. 4, 1968). (In French).

The energy spectra and the angular distributions of the ^{8}Li fragments produced by the interactions of K⁻ mesons at 3, 5, and 10.1 GeV/c are explained by a mechanism causing the nuclear cascade and the propagation of a hot point in the nucleus to occur simultaneously. (tr-auth)

14982 STUDY OF THE DI-PION FROM THE REACTION $\pi^- + p \rightarrow n + \pi^0 + \pi^0$ AT 1.53 AND 1.27 GeV/c INCIDENT MOMENTA. Feldman, M.; Frati, W.; Gleeson, R.; Halpern, J.; Nussbaum, M.; Richert, S. (Univ. of Pennsylvania, Philadelphia). Phys. Rev. Lett., 22: 316-18(Feb. 17, 1969).

The observation is reported of an s-wave $\pi^0\pi^0$ enhancement at 715 MeV of width 150 MeV by the study of the reaction $\pi^- + p \rightarrow n + \pi^0 + \pi^0$ in which the momentum of the neutron and the angles of the four gamma rays are all measured. (auth)

14983 SPIN–PARITY ANALYSIS OF 3π DECAYS IN THE A_2 MESON REGION. Chikovani, G. E.; Focacci, M. N.; Kienzle, W.; Kruse, U.; Lechanoine, C.; Martin, M.; Schuebelin, P. (CERN, Geneva). Phys. Lett., 28B: 526-30(Jan. 20, 1969).

A Dalitz plot with 600 events in the A_2 mass region was obtained at 7 GeV/c in the reaction $\pi^-p \rightarrow pA_2^-$, where $A_2^- \rightarrow \pi^-\pi^-\pi^-$, using a system of wire spark chambers in connection with the CERN-Missing-Mass Spectrometer. A spin parity analysis shows that for the overall A_2 region (1260 < M < 1360 MeV) $J^P = 2^+$ is favored $P(\chi^2) = 40\%$ over 1^-, 1^+, 2^-p (all with $P(\chi^2) < 0.5\%$). When the A_2 region is divided into A_2^{high} and A_2^{low} as suggested by the missing mass spectrum, the distributions still favor 2^+ over 1^-, particularly for A_2^{low}. (auth)

14984 PERIPHERAL PRODUCTION IN THE SINGLE-MESON-EXCHANGE FORBIDDEN REACTION $\pi^-p \rightarrow Y^{*-}K^+$ AT 2 TO 4 GeV/c. Abolins, Maris A. (Univ. of California, Berkeley); Dahl, Orin I.; Danburg, Jerome; Davies, Donald; Hoch, Paul; Miller, Donald H.; Rader, Robert; Kirz, Janos. Phys. Rev. Lett., 22: 427-30(Mar. 3, 1969).

Data are presented showing that the $Y_1^*(1385)$ production angular distribution in the reaction $\pi^-p \rightarrow Y^{*-}K^+$ and in its charge-symmetric counterpart $\pi^+n(p_{sp}) \rightarrow Y^{*+}K^0(p_{sp})$ is characterized by peripheral ($\hat{N}\cdot\hat{Y}^* \approx +1$) and antiperipheral peaking. Explanation for the latter is sought in terms of baryon exchange; so comparisons with other $\pi N \rightarrow Y^*K$ reactions are made. The peripheral peak cannot arise through the exchange of any known meson. Alternative explanations are considered. (auth)

14985 EXPERIMENTAL CONSISTENCY OF MULTI-REGGEISM IN A HIGH-ENERGY REACTION. Lipes, R. (California Inst. of Tech., Pasadena); Zweig, G.; Robertson, W. Phys. Rev. Lett., 22: 433-7(Mar. 3, 1969).

The reactions $\pi^- + p \rightarrow \pi^- + X + p$, $X \rightarrow \pi^+ + \pi^-$, for incident π^- energy of 25 BeV, was analyzed within the framework of the multi-Regge exchange model. (auth)

14986 DECAY MODES OF Σ(1660). Armenteros, R. (CERN, Geneva); Baillon, P.; Bricman, C.; (and others). Phys. Lett., 28B: 521-25(Jan. 20, 1969).

Values are given for the branching fractions of various decay modes of the hyperon resonance Σ(1660). The measurements were obtained in formation experiments of the type $K^-p \rightarrow \Sigma(1660) \rightarrow \bar{K}N, \Sigma\pi, \Lambda\pi, \Sigma\pi\pi$ and $\Lambda\pi\pi$. (auth)

14987 EXPERIMENTAL RESULTS FROM $K^- + p \rightarrow \Lambda + \eta$. Cox, B. B.; Fortney, L. R.; Carpenter, D. W.; Rose, C. M.; Fowler, E. C. (Duke Univ., Durham, N. C.). pp 157-71 of High Energy Physics and Fundamental Particles. Barut, Asim O.; Brittin, Wesley E. (eds.). New York, Gordon and Breach, Science Publishers, 1968.

A bubble chamber study of $K^- + p \rightarrow \Lambda + \eta$ interactions at 740 MeV/c is described. The differential cross section for $\Lambda + \eta$ production and the branching ratios for the η decay modes were determined. (W.H.K.)

14988 PARTIAL WAVE ANALYSIS OF THE REACTION $\pi^-p \rightarrow \Delta^-(1238)\pi^+$ BETWEEN 900 AND 1100 MeV/c. Brody, A. D. (Stanford Linear Accelerator Center, Calif.). pp 187-202 of High Energy Physics and Fundamental Particles. Barut, Asim O.; Brittin, Wesley E. (eds.). New York, Gordon and Breach, Science Publishers, 1968.

What has been learned about the so-called third pion nucleon resonance from phase shift analysis is reviewed, and why a study of the $\pi^- + p \rightarrow \Delta^-(1238) + \pi^+ \rightarrow \pi^+ + \pi^- + n$ interaction may be a powerful method of learning more is discussed. Preliminary data are presented. (W.H.K.)

14989 PRELIMINARY RESULTS ON $\pi^-\pi^-\pi^+$ MASS STRUCTURES IN π^-p INTERACTIONS AT 6.7 GeV/c. von Krogh, J.; Kopelman, J. B.; Libby, L. M. (Univ. of Colorado, Boulder). Contract AT(11-1)-1537. pp 213-22 of High Energy Physics and Fundamental Particles. Barut, Asim O.; Brittin, Wesley E. (eds.). New York, Gordon and Breach, Science Publishers, 1968.

The 3π effective mass in $\pi^- + p \rightarrow \pi^- + \pi^- + \pi^+ + p$ interactions at 6.7 GeV/c is studied. Particularly, events which have one $\pi^+\pi^-$ pair having the ρ mass (760 MeV) are examined. The mass region of the A-mesons is also investigated. (W.H.K.)

14990 ANALYSIS OF $\bar{K}N\pi\pi$ FINAL STATES PRODUCED IN K^-–PROTON INTERACTIONS AT 6 GeV/c. Colley, D. C.; Eastwood, D.; Macdonald, F. (Univ. of Birmingham, Eng.); and others. Nuovo Cim., 59A: 519-34(Feb. 21, 1969).

The reactions $K^-p \rightarrow K^-p\pi^-\pi^+$, $\bar{K}^0p\pi^-\pi^0$ and $\bar{K}^0n\pi^-\pi^+$ were studied in a bubble-chamber experiment with a beam of 6 GeV/c kaons. Cross sections are given for the various resonances produced in each channel. The low mass enhancement in the $K\pi\pi$ system is discussed. There is a significant difference in the production of the $K^{*-}(890)$ in the channels $K^{*-}n\pi^+$ and $K^{*-}p\pi^0$. No evidence of the L-meson, seen in other K^+ and K^- experiments, is found and an upper limit is set on its production. (auth)

14991 STRANGE AXIAL VECTOR MESONS AND KINEMATIC EFFECTS. Leitner, J. (Syracuse Univ., N. Y. Brookhaven National Lab., Upton, N. Y.). pp 1-18 of High Energy Physics and Fundamental Particles. Barut, Asim O.; Brittin, Wesley E. (eds.). New York, Gordon and Breach, Science Publishers, 1968.

Experimental data on the $K\pi\pi$ system from K^-p and K^-p interactions mainly in the ~5 GeV/c range are reviewed and interpreted. (L.B.S.)

14992 THE 2^+ NONET REVISITED. Leitner, J. (Syracuse Univ., N. Y. Brookhaven National Lab., Upton, N. Y.). pp 19-34 of High Energy Physics and Fundamental Particles. Barut, Asim O.; Brittin, Wesley E. (eds.). New York, Gordon and Breach, Science Publishers, 1968.

New experimental data on the f* and K** from the BNL-Syracuse study of ~5-GeV/c K^-p interactions are discussed. Data obtained from other sources on the A_2 are also included. Decay rates and spin-parity assignments are discussed. A comparison is given between the latest strong decay rates and unbroken SU(3) predictions. (L.B.S.)

14993 BREAKDOWN OF THE VECTOR DOMINANCE RELATION BETWEEN ρ^0,ω PRODUCTION, AND POLARIZED PHOTOPRODUCTION. Gutay, L. J.; Meiere, F. T.; Scharenguivel, J. H.; Miller, D. H.; Miller, R. J.; Lichtman, S.; Willmann, R. B. (Purdue Univ., Lafayette, Ind.). Phys. Rev. Lett., 22: 424-6(Mar. 3, 1969).

The validity of vector-meson dominance is tested by comparing the high statistics ρ^0 and ω production experiments at 2.7 and 4 GeV/c with the results of polarized photopion production experiments. The results suggest the breakdown of the vector-dominance model even after taking into account the strong S-wave $\pi\pi$ interaction in the ρ^0 region. (auth)

Particle Interactions and Properties (Theoretical)

General

14994 (CALT-68-179) PROJECTION OPERATORS FOR PARTICLES OF ANY SPIN. Rebbi, C. (California Inst. of Tech., Pasadena). Jan. 8, 1969. Contract AT(11-1)-68. 10p. Dep. CFSTI.

Projection operators for particles of any spin are defined, and calculations of contracted projection operators are given for the cases of integer and half-integer spins. The expressions are generalized to give the relativistic contracted projection operators. (L.B.S.)

14995 (ITF-68-27) PROBLEM OF "UNITARIZATION" OF RELATIONS BETWEEN OPERATORS IN THE HEISENBERG AND INTERACTION REPRESENTATIONS. Sukhanov, A. D. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1968. 16p. (In Russian). (CONF-680453-11). Dep.

From 2nd Conference on Axiomatical Field Theory and Theory of Elementary Particles, Kiev, USSR.

It is shown that the relations between individual operators in the Heisenberg and interaction representations can be written in a formally unitary form if one employs a certain pseudo-unitary operator as the "half" S-matrix. However, relations between Heisenberg fields and their time derivatives can be "unitarized" only with the help of various pseudo-unitary operators. Thus, the connection between the two representations of canonical commutation relations in the real theory have canonical character rather than unitary one. (auth)

14996 (ITF-68-28) MASS RENORMALIZATION AND FIELD "DRESSING" MODEL. Medvedev, B. V.; Polivanov, M. K.; Sukhanov, A. D. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1968. 11p. (In Russian). (CONF-680453-8). Dep.

From 2nd Conference on Axiomatical Field Theory and Theory of Elementary Particles, Kiev, USSR.

The bilinear model of mass renormalization is explicitly solved, as well as the same model taking additionally into account field operator dressing by contributing an appropriate counterpart. The effect of this counterpart can be accounted for in two ways. One may either renormalize the charge without changing the functional field argument or renormalize the proper field argument without changing the charge. In both the cases one obtains self-consistent sets of relations which are to be a hypothesis on the renormalization character in a realistic theory. (auth)

14997 RECENT DEVELOPMENTS IN THE STUDY OF THE ANALYTICITY IN J: FIXED POLES. Jengo, R. (CERN, Geneva). Nuovo Cim., Suppl., 6: 638-49(1968).

Some recent work on fixed poles in the J plane is summarized. The features of the fixed poles and the connection between fixed poles and asymptotic behavior in the energy of the crossed channel, the implications of unitarity and the case in which the external particles have spin are discussed. Also the role of fixed poles in weak processes and the Gribov–Pomeranchuk phenomena are considered. (J.F.P.)

14998 FINAL STATE INTERACTIONS. Wolters, G. F. (Zeeman Lab., Amsterdam). pp 493-539 of Methods in Subnuclear Physics. Vol. 2. Nikolic, M. (ed.). New York, Gordon and Breach, Science Publishers, Inc., 1968.

A review is given of the early development of the theory of final state interactions. The first topic deals with final state interactions near the threshold for production of long lived particles. Baryon isobars in final states are then discussed. Triangle diagrams for the generalized Peierls mechanism are treated, and examples are given of triangle singularities. (L.B.S.)

14999 METHODS IN SUBNUCLEAR PHYSICS. VOLUME II. Nikolic, M. (ed.). International School of Elementary Particle Physics, Herceg-Novi (Yugoslavia). New York, Gordon and Breach, Science Publishers, Inc., 1968. 856p. $51.50 cloth, $24.00 paper.

Separate abstracts are prepared for the nineteen lectures included. (L.B.S.)

For abstracts of individual chapters see: 14977, 14998, 15000, 15031, 15070, 15072, 15073, 15092, 15094, 15095, 15125, 15158–15160, 15202, 15210, 15265, and 15306.

15000 CURRENT ALGEBRA. Amati, D. (CERN, Geneva. Univ., Trieste, Italy). pp 769-97 of Methods in Subnuclear Physics. Vol. 2. Nikolic, M. (ed.). New York, Gordon and Breach, Science Publishers, Inc., 1968.

The basic ideas of the current algebra approach are discussed in the introduction. The remaining sections deal with low energy theorems, sum rules, and superconvergence. The main applications to physical problems are reviewed. (L.B.S.)

15001 RELATIVISTIC CENTER-OF-MASS VARIABLES FOR TWO-PARTICLE SYSTEMS WITH SPIN. Osborn, Hugh (Univ. of Sussex, Brighton, Eng.). Phys. Rev., 176: 1514-22 (Dec. 25, 1968).

The definition of the total momentum, position, and spin for Galilean- or Lorentz-invariant two-free-particle systems is discussed by using the requirement that the generators of the respective invariance groups should have the same form expressed in terms of them as for a single particle. Internal c.m. dynamical variables are introduced by applying the singular transformation due to Gartenhaus and Schwartz on the basic single-particle dynamical variables, the transformation mapping the whole Hilbert space onto the c.m. subspace spanned by states of zero total momentum. The form of the internal c.m. position operator is given for particles with spin, for what appears to be the first time. Using these dynamical variables, it is shown how an interaction can be introduced while maintaining Galilean or Lorentz invariance and satisfying the asymptotic condition of freely propagating particles for large separations. (auth)

15002 THEORIES AT INFINITE MOMENTUM. Bardakci, K.; Halpern, M. B. (Univ. of California, Berkeley). Phys. Rev., 176: 1686-99(Dec. 25, 1968).

Galilean-invariant theories (with Schrödinger equations) at infinite momentum are constructed that describe interacting relativistic systems. Classes of both first- and second-quantized theories are presented. The formalism provides a general approach to the saturation of current algebra; positivity of the mass spectrum is guaranteed, and as much inelasticity as necessary may be introduced. More generally, however, such theories offer the hope of potential-theoretic intuition for relativistic physics. (auth)

15003 SIMPLEST DYNAMIC MODELS OF COMPOSITE PARTICLES. Tavkhelidze, A. (Joint Inst. for Nuclear Research, Dubna, USSR). Proc. Conf. Phys., 14th, Univ. Brussels, 1967, 145-54(1968).

From 14th Conference on Physics, Brussels, Belgium. See CONF-671076.

An account is given of the work done by N. N. Bogoliubov and coworkers concerning the study of electromagnetic and weak vertices of mesons and baryons in the simplest relativistic quark model. The semirelativistic model of quasi-independent quarks is first considered, followed by a discussion of the method of construction of relativistic models. In the former case quarks in mesons or in baryons are considered as particles moving in a certain self-consistent field. In the latter case the problem of finding the vector and axial vertices of a composite particle in the relativistic quark model arises. (UK)

15004 REPORT ON THE PRESENT SITUATION IN THE NONLINEAR SPINOR THEORY OF ELEMENTARY PARTICLES. Heisenberg, W. (Max-Planck Inst., Munster, Ger.). Proc. Conf. Phys., 14th, Univ. Brussels, 1967, 129-44(1968).

From 14th Conference on Physics, Brussels, Belgium. See CONF-671076.

The nonlinear spinor theory, as an attempt for a more fundamental theory of elementary particles, rests on the conviction that the complicated spectrum of elementary particles must finally be deducible from an underlying natural law. The mathematical structure of the theory is first described, followed by a discussion of the symmetry properties of the spinor equation and their experimental consequences. The methods and results of the theory are also compared with those of more conventional schemes. (UK)

15005 NATURE OF PRIMARY INTERACTIONS OF ELEMENTARY PARTICLES. Sudarshan, E. C. G. (Syracuse Univ., N. Y.). Proc. Conf. Phys., 14th, Univ. Brussels, 1967, 53-64(1968).

From 14th Conference on Physics, Brussels, Belgium. See CONF-671076.

The following are discussed: The four-fermion interaction and need for a new theory; primary interaction Lagrangian (electromagnetism, strong interactions, weak interactions); induced electromagnetism; induced weak interactions; strange particle weak interaction and suppression of leptonic decays; consequences for strong interactions. Attempts are made to identify specific primary interactions obeying simple rules and leading to a unified treatment of strong, electromagnetic, and weak interactions. The vector-axial vector structure, first deduced from weak interaction data, is seen to be equally important in strong interactions. Such diverse items of particle physics as nucleon magnetic moments, beta decay couplings, weak magnetism, absence of neutral lepton currents, absence of scalar mesons, apparent suppressing of strange particle decays, pion-nucleon scattering lengths, and the general features of the nucleon-nucleon interaction, are correlated by the theory. (UK)

15006 T-PRODUCTS AND SPECTRAL-FUNCTION SUM RULES IN A THEORY OF CURRENTS. Bierter, W.; Bitar, K. M. (Univ. of California, Berkeley). Nuovo Cim., Lett., 1: 192-6(Jan. 21, 1969).

A method for deriving spectral function sum rules in a theory of currents is discussed. The vector and axial vector currents in the Sugawara theory are considered. (L.B.S.)

15007 FUNDAMENTAL PROBLEMS IN ELEMENTARY PARTICLE PHYSICS. Proceedings of the Fourteenth Conference on Physics at the University of Brussels, October 1967. Proc. Conf. Phys., 14th, Univ. Brussels, 1967, 1-250(1968). (CONF-671076).

Nine papers were presented, abstracts for all of which have been prepared. (UK)

For abstracts of individual papers see: 15003–15005, 15163, 15214–15217, and 15271.

15008 PRESENT STATE OF ELEMENTARY PARTICLE PHYSICS. Pietschmann, Herbert (Univ., Bonn). Acta Phys. Austr., 27: 174-85(1968). (In German).

The most significant theoretical and experimental results on lepton processes and phenomena, semi-lepton processes, and nonlepton processes are summarized in a bibliographic review. 36 references. (J.S.R.)

15009 REVIEW OF PARTICLE PROPERTIES. Barash-Schmidt, Naomi (Univ. of California, Berkeley); Barbaro-Galtieri, Angela; Price, Leroy R.; Rosenfeld, Arthur H.; Soeding, Paul; Wohl, Charles G.; Roos, Matts; Conforto, Gianni. Rev. Mod. Phys., 41: 109-92(Jan. 1969).

This review of the properties of leptons, mesons, and baryons is an updating of Rosenfeld et al. (Rev. Mod. Phys., 40: 77(1968)). Data are evaluated, listed, averaged, and summarized in tables and wallet sheets. A data booklet is also available. (auth)

15010 CALCULATION OF THE MASS RELATION OF THE PROTON AND ELECTRON. Stanyukovich, K. P. Vestn. Mosk. Univ., Ser. III. Fiz. Astron., No. 4, 46-49(July-Aug. 1968). (In Russian).

The difference in the masses of the nucleon and electron is evaluated from the point of view of quadrupole gravitational radiation of the particle. The mass relation obtained by this method coincides with experiment to a sufficient degree of accuracy. (tr-auth)

15011 PARTICLE SPECTRUM AND GEOMETRICAL SYMMETRY. Burcev, P. (Purkyne Univ., Brno). Czech. J. Phys., 19: 195-203(1969).

The spectrum of unstable particles is studied on a model meeting the requirement of geometrical symmetry expressed by the restricted Lorentz group L_+, which is represented by an unstable particle model described by the invariant tensor or spintensor of the group L_r satisfying the Klein–Gordon equation. The problem of the spectrum of particle models is formulated and treated as a certain eigenvalue problem invariant with regard to L_+. The calculated spectrum of the reduced levels mass/width of the particle models is spin independent, agrees with the observed spectrum of resonances and shows that the model employed represents certain laws manifesting themselves in the observed spectrum of unstable particles. (auth)

15012 SOME REMARKS ABOUT PARTICLE–ANTIPARTICLE SUPERSELECTION RULES. Ascoli, R.; Teppati, G.; Termini, S. (Univ., Palermo, Italy). Nuovo Cim., Lett., 1: 223-7(Feb. 1, 1969).

Nonzero-mass particle–antiparticle doublets are considered from the point of view of the representation theory of the extended Poincaré group. Also a necessary and sufficient condition is formulated for the occurrence of a superselection rule between particle and antiparticle states. (J.F.P.)

15013 ALGEBRA OF CURRENTS ON THE LIGHT CONE. Jersak, J.; Stern, J. (Charles Univ., Prague). Nuovo Cim., 59A: 315-27(Feb. 1, 1969).

On the basis of observation that the fixed-mass sum rules are Fourier transforms of the commutators of currents on a lightlike hyperplane a new treatment of the algebra of currents is proposed. It consists in use of the currents integrated over the lightlike hyperplane ("lightlike" charges) and thus includes the commutators of currents on the whole light cone. An algebra of the lightlike charges is a sufficient assumption for the derivation of the

fixed-mass sum rules and may be represented in the one-particle space with any momenta. Hence this extension of the usual equal-time current algebra allows one to abandon the methods like $p \to \infty$ without losing any of its advantages. (auth)

15014 IMPACT PARAMETER DESCRIPTION OF HIGH ENERGY SCATTERING. Islam, M. M. (Brown Univ., Providence). pp 97-156 of High Energy Physics and Fundamental Particles. Barut, Asim O.; Brittin, Wesley E. (eds.). New York, Gordon and Breach, Science Publishers, 1968. (NYO-2262TA-165).

A brief derivation is given of the eikonal approximation from the Klein-Gordon equation. The impact parameter representation of the elastic scattering amplitude is constructed and the total and elastic cross sections are calculated in this representation. The unitarity condition is formulated using the overlap function. The properties of the impact parameter amplitude are discussed. The optical potential in the impact parameter description is treated. Applications are made to Coulomb scattering and bound states in a Coulomb potential; high energy proton-proton scattering and the hadronic structure of the proton; and the high energy behavior of diffraction peaks. (L.B.S.)

15015 HIGH ENERGY PHYSICS AND FUNDAMENTAL PARTICLES. Barut, Asim O.; Brittin, Wesley E. Lectures in Theoretical Physics. Volume X-B. New York, Gordon and Breach, Science Publishers, 1968. 728p. $37.50 (cloth); $25.00 (paper).

Separate abstracts are prepared for the thirty-four lectures presented on high-energy physics and fundamental particles. (L.B.S.)

For abstracts of individual papers see: 14647, 14955, 14967, 14987–14989, 14991, 14992, 15014, 15060–15062, 15081–15083, 15107, 15109, 15142, 15156, 15177–15180, 15184, 15191, 15192, 15228–15230, and 15288–15291.

Electromagnetic

Refer also to abstracts 14932, 15053, 15066, 15089, and 15244.

15016 (IFVE-STF-68-32-K) LOW BOUNDARY OF DECREASING FORM FACTORS. Volkov, G. G.; Ezhela, V. V.; Mestvirishvili, M. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). 1968. 10p. (In Russian). Dep.

A lower limit of form factors decreasing in the region of large momentum transfer is found. Exponential character of the decreasing of the pions and nucleons electromagnet form factors is estimated. (auth)

15017 DISCREPANCY BETWEEN THE VECTOR-DOMINANCE MODEL AND PION PRODUCTION BY POLARIZED PHOTONS. Diebold, R. (Stanford Univ., Calif.); Poirier, J. A. Phys. Rev. Lett., 22: 255-7(Feb. 10, 1969).

The helicity density matrix for the process $\pi^- p \to \pi^+ \pi^- n$ has been studied as a function of $M_{\pi\pi}$. The ratio $\rho_{1-1}^{hel}/\rho_{11}^{hel}$ shows no variation with $M_{\pi\pi}$ and it thus seems unlikely that the large discrepancy between the vector-dominance prediction and the observed asymmetry of single pions produced by linearly polarized photons could be the result of density-matrix distortion caused by background interference. (auth)

15018 DOUBLE BREMSSTRAHLUNG FROM ELECTRON COLLISIONS: HARD END OF THE SPECTRUM. Baier, V. N.; Galitskii, V. M.; Fadin, V. S.; Khoze, V. A. (Novosibirsk State Univ., USSR). Yadern. Fiz., 8: 1174-80(Dec. 1968). (In Russian).

Properties of the double bremsstrahlung in the hard part of the spectrum on one and both the photons are investigated. It is shown that at the end of the spectrum the cross section has no local peaks that may give a finite contribution to the cross section integrated over a narrow interval of the end of the spectrum. A variation of the method for invariant integration of tensors is used in which the frequencies of the emitted photons are not fixed. (auth)

15019 RADIATIVE CORRECTIONS TO NEUTRINO ANNIHILATION OF LEPTON-ANTILEPTON PAIR. Tsvetkov, V. P.; Kerimov, B. K. (Moscow State Univ.). Yadern. Fiz., 8: 1171-3 (Dec. 1968). (In Russian).

Some formulae are obtained for differential and total cross sections of the processes of neutrino annihilation of an electron-positron (or muon) pair taking into account electromagnetic correction of the order of α. (auth)

15020 ELASTIC π^0-MESON PHOTOPRODUCTION ON ^{4}He. Gur'ev, V. N. (Physical-Technical Inst., Kharkov). Yadern. Fiz., 8: 1232-5(Dec. 1968). (In Russian).

Numerical values for the differential cross sections of the elastic π^0-photoproduction on ^{4}He nucleus are obtained for the photon lab energy interval 160–450 MeV and for the emission angle interval 10–140° (c.m.s.). The amplitude was approximated by the first anomalous singularity in the momentum transfer due to the triangle diagram. The formfactor of the ^{4}He nucleus is assumed to be of the Gaussian form with the mean-square radius $\langle r \rangle = 1.4$ and 1.61 f. The theoretical results are compared with the experimental data. A reasonable agreement with the experiment is obtained in the photon energy interval 160–210 MeV and in the meson emission angle interval 80–90° provided $\langle r \rangle = 1.4$ f. (auth)

15021 TRAJECTORY AND MASS SHIFT OF A CLASSICAL ELECTRON IN A RADIATION PULSE. Eberly, Joseph H.; Sleeper, Arthur (Univ. of Rochester, N. Y.). Phys. Rev., 176: 1570-3(Dec. 25, 1968).

The Hamilton-Jacobi equations of motion of a classical charge in the presence of a traveling pulse of electromagnetic radiation are solved. The orbit solutions for arbitrary radiation pulse shape are given in terms of one-dimensional integrals, and for a particular choice of singly peaked pulse shape are given in detail as a function of the particle's proper time. The question of the particle mass is then investigated, and an expression for the classical interacting mass is given as an explicit function of the time width of the radiation pulse. The average shift in the square of the mass, Δm^2, varies smoothly from zero to a maximum and then to zero again as the pulse overtakes and passes the charged particle. The maximum value is $\Delta m^2 = \frac{1}{2}e^2a^2$ (where e and a are the particle charge and the field amplitude). It is concluded that for the free-electron-photon scattering experiments currently being contemplated at optical frequencies the maximum figure is likely to be the relevant one. (auth)

15022 EXACTLY SOLUBLE NONRELATIVISTIC MODEL OF PARTICLES WITH BOTH ELECTRIC AND MAGNETIC CHARGES. Zwanziger, Daniel (New York Univ., N. Y.). Phys. Rev., 176: 1480-8(Dec. 25, 1968).

The quantum-mechanical problem of the interaction of two particles, each with arbitrary electric and magnetic charges is considered. It is shown that if an additional $1/r^2$ potential, of appropriate strength, acts between the particles, then the resulting Hamiltonian possesses the same higher symmetry as the nonrelativistic Coulomb problem. The bound-state energies and the scattering phase shifts are determined by an algebraic and gauge-independent method. If the electric and magnetic coupling parameters are α and $\mu = 0, \pm\frac{1}{2}, \pm 1, \ldots$, then the bound states correspond to the representations $n_1 + n_2 = |\mu|, |\mu| + 1, \ldots, n_1 - n_2 = \mu$ of $SU_2 \otimes SU_2 \sim O_4$, and the scattering states correspond to the representations of $SL(2,C) \sim O(1,3)$ specified by $J^2 - K^2 = \mu^2 - \alpha'^2 - 1$, $J \cdot K = \alpha'\mu$, with $\alpha' = \alpha/v$. Thus, as α and μ are varied, all irreducible representations of O_4 and all irreducible representations in the principal series of $O(1,3)$ occur. The scattering matrix is expressed in closed form, and the differential cross section agrees with its classical value. Some results are obtained which are valid in a relativistic quantum field theory. The S matrix for spinless particles is found to transform under rotations like a $\mu \to -\mu$ helicity-flip amplitude, which contradicts the popular assumption that scattering states transform like the product of free-particle states. It is seen that the Dirac charge quantization condition means that electromagnetic interactions are characterized not by one but by two, and only two, free parameters: the electronic charge $e \approx (137)^{-\frac{1}{2}}$, and the electric charge of the magnetic monopole, whose absolute magnitude is not fixed by the Dirac quantization condition but which defines a second elementary quantum of electric charge (auth)

15023 LOW-ENERGY THEOREMS FOR e^4 COMPTON SCATTERING AMPLITUDES. Cheng, T. P. (Rockefeller Univ., New York). Phys. Rev., 176: 1674-9(Dec. 25, 1968).

Unitarity and fixed-momentum-transfer dispersion relations are used to evaluate the contribution to the e^4 Compton amplitude from the intermediate state of target plus soft photon. It is found that the leading term goes like $\omega^2 \ln\omega$ for scattering of photons of low frequency (ω) by either spin-0 or spin-$\frac{1}{2}$ targets. The e^4 amplitudes up to this order ($\omega^2 \ln\omega$) are shown to be structure-independent as a consequence of the usual Compton-scattering low-energy theorems, which have been proven rigorously only in order e^2. (auth)

15024 K*(890) PHOTOPRODUCTION IN THE REGGE-POLE MODEL. Thornber, N. S. (Stanford Univ., Calif.). Phys. Rev., 176: 1998-2002(Dec. 25, 1968).

The Regge-pole model is applied to K*(890) photoproduction. Conspiracy relations, kinematic constraints, factorization, and the question of when to set $m_\gamma = 0$ are discussed. Predictions are obtained, in the limit of large s and small t, for $d\sigma/d\Omega$, the density matrix, and the K*-decay angular distribution. (auth)

15025 MODEL OF HIGH-ENERGY MESON PHOTOPRODUCTION. Chou, T. T. (State Univ. of New York, Stony Brook). Contract AT(30-1)-3668B. Phys. Rev., 176: 2041-4(Dec. 25, 1968).

A modified coherent-droplet model for high-energy meson photoproduction is presented. Results are found to be in very good agreement with presently available experimental data of ρ, π, and K production. (auth)

15026 PHOTON SCATTERING FROM BOUND ATOMIC SYSTEMS AT VERY HIGH ENERGY. Goldberger, M. L. (Palmer Physical Lab., Princeton, N. J.); Low, F. E. Contract AF49(638)-1545. Phys. Rev., 176: 1778-81(Dec. 25, 1968).

The elastic scattering of photons from bound atomic systems is studied in the limit of infinitely high energy. It is found that the amplitude differs significantly from the free-particle value when the binding is strong. Explicit formulas for a spin-0 particle bound in a 1/r potential (both world-scalar and Coulomb) are obtained as well as power series in the coupling strength for a spin-$\frac{1}{2}$ target. The general result in the latter case is reduced to quadratures. (auth)

15027 CANCELLATION OF DIVERGENCES IN REGGEIZED ELECTROMAGNETIC MASS DIFFERENCES. Rabl, Arnulf (Univ. of California, Berkeley). Phys. Rev., 176: 2034-40 (Dec. 25, 1968).

By use of Regge theory and the Cottingham formula, the divergences of electromagnetic mass differences are isolated in Minkowski space. Sum rules are derived which are necessary and sufficient to remove them; they also turn out to be the necessary and sufficient conditions for the Wick rotation to Euclidean space via $q_0 \rightarrow iq_0$. Bjorken's argument for logarithmic divergences due to current algebra is extended to the case where subtractions are needed in the dispersion relations. The connection between the divergence, the commutator $[[j_0(0,x),H],j^\mu(0)]$, and the fixed pole at J = 0 is clarified. The asymptotic value of the fixed-pole residue is found in terms of this commutator. (auth)

15028 COMPTON SCATTERING OF SPIN-ONE PARTICLES. Tung, Wu-ki (State Univ. of New York, Stony Brook). Phys. Rev., 176: 2127-34(Dec. 25, 1968).

Kinematic singularity- and zero-free invariant amplitudes for Compton scattering of spin-one particles are derived. Gauge invariance is automatically satisified. A complete set of low-energy theorems is obtained. In addition to the well-known first-order theorems, higher-order theorems also exist. It is shown that up to second order in the photon energy the 12 independent amplitudes are determined by the static moments of the target particle plus four dynamic structure-dependent constants; up to third order they are determined by the static moments plus eight additional constants. Dispersion relations may be written down for the invariant amplitudes without any ad hoc subtractions. The asymptotic behavior of these amplitudes is carefully examined, leading to a systematic derivation of possible sum rules and superconvergence relations. Generalizations of previously known sum rules as well as new ones are obtained. (auth)

15029 VIRTUAL-PHOTON–PION SCATTERING, HARD-PION CURRENT ALGEBRA, AND DISPERSION RELATIONS. Gupta, K. C. (Univ. of Notre Dame, Ind.); Vaishya, J. S. Phys. Rev., 176: 2125-7(Dec. 25, 1968).

It is shown that the SU(2) × SU(2) current-algebra results for three- and four-point functions are broadly consistent with dispersion relations and the present saturation scheme, provided once-subtracted dispersion relations are written for some of the form factors occurring in the virtual-photon-pion scattering amplitude. (auth)

15030 LOW-ENERGY COMPTON SCATTERING BY ARBITRARY-SPIN TARGETS. Kalet, Ira J. (Princeton Univ., N. J.). Phys. Rev., 176: 2135-9(Dec. 25, 1968).

The classic low-energy theorem for low-energy Compton scattering by spin-$\frac{1}{2}$ systems derived in 1954 by Low and by Gell-Mann and Goldberger is generalized to include targets of arbitrary spin. Low's method is used in conjunction with a multipole expansion of the electromagnetic current matrix elements. The multipole expansion is given in the Breit frame (total three-momentum = 0) and transformed to the lab system. The result, obtained by replacing the Pauli matrix σ in the Low–Gell-Mann–Goldberger result by 2S (where S is the target spin operator), has been derived by Lapidus and Kuang–Chao, but their method of obtaining the current matrix elements is less straightforward than the present one. (auth)

15031 DISPERSION RELATIONS AND THE FORM FACTORS OF ELEMENTARY PARTICLES. Issev, P. S. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 113-41 of Methods in Subnuclear Physics. Vol. 2. Nikolic, M. (ed.). New York, Gordon and Breach, Science Publishers, Inc., 1968.

The lectures discuss in a simple form the concepts of the elementary particle form factors by means of dispersion relations and the interpretation of the experimental data on the electron-nucleon scattering by introducing the nucleon form factors. (L.B.S.)

15032 EFFECT OF THE ANOMALOUS MAGNETIC MOMENT OF THE ELECTRON ON THE NONLINEAR LAGRANGIAN OF THE ELECTROMAGNETIC FIELD. O'Connell, R. F. (Louisiana State Univ., Baton Rouge). Phys. Rev., 176: 1433-7 (Dec. 25, 1968).

When the anomalous magnetic moment of the electron ($g \neq 2$) is considered, by adding a phenomenological Pauli term to the Dirac Hamiltonian, the exact solutions to the Dirac equation can still be found. Using these solutions, and the methods of Heisenberg and Euler and of Weisskopf, in addition to the usual nonlinear term, a new nonlinear term is derived which is correct to relative order α^2. (auth)

15033 COMMENTS ON THE CLASSICAL THEORY OF MAGNETIC MONOPOLES. Gamblin, Rodger L. (IBM System Development Div., Endicott, N. Y.). J. Math. Phys. (N.Y.), 10: 46-8(Jan. 1969).

The classical theory of electromagnetism including magnetic monopoles is formulated in terms of harmonic functions. The fact that there is no consistent action-integral formulation of the field that yields both particle and field equations for both electric and magnetic charges is discussed in detail. It is seen that a consistent formulation can be developed through an action integral, but, in such a development, a monopole does not have what has been considered to be an appropriate interaction with either an electric charge or another monopole. (auth)

15034 ELECTROMAGNETIC MASS DIFFERENCES. Kuehnelt, H. (Univ., Graz). Acta Phys. Austr., 27: 107-11(1968). (In German).

The isospin current algebra and the Fubini-Furlan method was used to calculate $\Delta I = 2$ mass differences. For $\pi^+ - \pi^0$ mass difference with $p \rightarrow 0$ a value of 9.4 MeV and with $p \rightarrow \infty$ a value of 2.85 MeV was obtained in comparison with the experimental value of 4.6 MeV. The $\Sigma^+ + \Sigma^- - 2\Sigma^0$ mass difference had a theoretical value of 1.16 MeV; the experimental value was 1.76 ± 0.2 MeV. (J.S.R.)

15035 RADIATIVE CORRECTIONS. TWO OR MORE OBSERVATION UNCERTAINTIES. Widder, F. (Univ., Graz). Acta Phys. Austr., 27: 102-6(1968). (In German).

Examples are given of the calculation of radiative corrections in elastic electron-proton scattering and inelastic electron-proton scattering when there are two or more measurement inaccuracies. (J.S.R.)

15036 PROTON–PROTON BREMSSTRAHLUNG. Baier, R. (Univ., Graz). Acta Phys. Austr., 27: 86-91(1968). (In German).

A theoretical study was made of the off-energy-shell behavior of proton–proton interactions, using the two-potential formalism of the nonrelativistic scattering theory to obtain the scattering matrix for the process. The strong interactions were complete and the Coulomb interaction was handled in the first order. The bubbles were described by the exact off-energy-shell scattering amplitudes of the strong interaction, which can be calculated with a potential model. The energy dependence of the effective cross section was determined, and a great discrepancy with experimental results was shown. (J.S.R.)

15037 THE CONSERVATION OF THE SIX-COMPONENT ANGULAR MOMENTUM IN THE ELECTROMAGNETIC INTERACTION THEORY OF WHEELER AND FEYNMAN. Costa de Beauregard, Olivier (Institut Henri Poincare, Paris). Compt. Rend., Ser. A and B, 267: 727-8(Nov. 4, 1968). (In French).

The expression for the law of the conservation of the angular momentum was derived in the Wheeler and Feynman theory of the electromagnetic interaction. (J.S.R.)

15038 SCATTERING OF POLARIZED LEPTONS AT HIGH ENERGY. Dombey, Norman (Harvard Univ., Cambridge, Mass.). Rev. Mod. Phys., 41: 236-46(Jan. 1969).

A unified treatment is given of the high-energy elastic and inelastic electromagnetic scattering of electrons and muons by hadrons in terms of the polarization density matrix of the virtual photon exchanged. It is shown that when the leptons are longitudinally polarized, the virtual photon is in a pure polarization state which is a coherent superposition of an elliptically polarized

transverse state and a longitudinal state. Experiments utilizing these features are suggested and the formulas for the cross sections are obtained. The limit in which the virtual photon is almost real is investigated carefully. Finally, it is shown that the formalism is immediately applicable to neutrino scattering. (auth)

15039 RADIATIVE CORRECTIONS TO ELASTIC AND INELASTIC ep AND μp SCATTERING. Mo, L. W.; Tsai, Y. S. (Stanford Univ., Calif.). Rev. Mod. Phys., 41: 205-35(Jan. 1969).

The reliability of many formulas used in the radiative corrections to elastic and inelastic electron scatterings when only the scattered electrons are detected are investigated and improved. The radiative corrections to muon scattering are also investigated. A practical and reliable recipe for unfolding the entire inelastic spectra, including effects due to virtual photons, internal and external bremsstrahlungs, is given. Examples of actually unfolding the inelastic electron spectra are given using the experimental data obtained by the electron-scattering group at the Stanford Linear Accelerator Center. (auth)

15040 COMMENTS ON RADIATIVE CORRECTIONS. Maximon, L. C. (National Bureau of Standards, Washington, D. C.). Rev. Mod. Phys., 41: 193-204(Jan. 1969).

A review is presented of the literature on radiative corrections to electron scattering, a summary of the essential elements of the theory in a manner hopefully useful to experimenters, and comments on certain aspects of the subject that need further investigation. (auth)

15041 POSSIBILITY OF NEGATIVE CHERENKOV ABSORPTION. Galtsov, D. V. Vestn. Mosk. Univ., Ser. III. Fiz. Astron., No. 4, 3-10(July-Aug. 1968). (In Russian).

Conditions were found under which there is observed negative Cherenkov absorption at resonance and near resonance. It was shown that in a homogeneous magnetic field and parallel to the velocity the Cherenkov cone is split into three cones one of which is of greater intensity. (tr-auth)

15042 THRESHOLD THEOREMS FOR THE PHOTODISINTEGRATION OF THE DEUTERON. Le Bellac, M. (Physique Theorique, Nice). Nuovo Cim., 59B: 110-20(Feb. 11, 1969).

Low-energy theorems for the photodisintegration of the deuteron are derived from the kinematical singularities and constraints of helicity amplitudes and the usual analyticity assumptions. It is shown that the electric-dipole amplitudes are given to zeroth and first orders in the photon energy by the Born term, but that the magnetic amplitudes are given only to order zero. The error introduced by the extrapolation of these results to threshold is discussed; also gives a brief comparison with the nonrelativistic theory, and especially Siegert's theorem is given. (auth)

15043 RELATIVISTIC INVARIANCE WITHOUT ANGULAR-MOMENTUM CONSERVATION. Peres, A. (Israel Inst. of Tech., Haifa). Nuovo Cim., Lett., 1: 245-6(Feb. 1, 1969).

Some examples of Lorentz-invariant processes in which angular momentum is not conserved are discussed. (J.F.P.)

15044 COMMENTS ON FIXED POLES IN PHOTOPRODUCTION AMPLITUDES. Dashen, Roger (Inst. for Advanced Study, Princeton, N. J.); Lee, S. Y. Phys. Rev. Lett., 22: 366-7(Feb. 24, 1969).

It is pointed out that high-energy, backward pion photoproduction is the best place to look for right-signature fixed poles. Also a new argument is summarized based on a potential-theory model, that such fixed poles are absent when the external particles lie on Regge trajectories. (auth)

15045 PHOTOPRODUCTION OF π-MESONS. Berends, Frederik Allard. Leiden, Univ. of Leiden, 1967. 99p.

Thesis.

The cross section for the production of a pion from the collision of a photon and a nucleon $\gamma + N \rightarrow \pi + N$ is calculated. Kinematical and dynamical concepts, dispersion relations, and multipole amplitudes are covered. (J.F.P.)

15046 THEORY OF MESON PHOTOPRODUCTION ON NUCLEONS. Izmailov, S. V.; Smirnov, A. I. (Leningrad Pedagogical Inst.). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 11, 135 (1967). (In Russian).

Photoproduction of π mesons on nucleons(N) in semiclassical theory of strong coupling was developed previously. This was further developed by the authors. The photoproduction of π-mesons on nucleons through a nucleon resonance N* (with spin $J = 3/2$, isospin $I = 3/2$, mass $M(N^*) = 1236$ MeV, and width $\Gamma = 120$ MeV; $\gamma + N = N^* \rightarrow N + \pi$ was reported by A. Rosenfeld et al. (Rev. Mod. Phys. 37, 633, 1965). An assumption was made that the photoproduction of ρ mesons passed through resonance N** with spin $J = 5/2$, isospin $I = 3/2$, $M(N^{**}) \approx 2600$ MeV, $\Gamma \approx 350$ MeV; $\gamma + N \rightarrow N^{**} \rightarrow N + \rho$. The differential cross section for ρ-meson photoproduction is given. (R.V.J.)

15047 FLUX QUANTIZATION, CHARGE QUANTIZATION, AND THE ELECTROMAGNETIC INTERACTION CONSTANT. Jehle, Herbert (George Washington Univ., Washington, D. C.). pp 673-89 of High Energy Physics and Fundamental Particles. Barut, Asim O.; Brittin, Wesley E. (eds.). New York, Gordon and Breach, Science Publishers, 1968.

An attempt is made to calculate the size of the electromagnetic interaction constant within the framework of the Dirac theory of the electron, used to describe the motion of a "first" lepton in an electromagnetic field. The inhomogeneous part of Maxwell–Lorentz equations which describes the source of the electromagnetic field (the field of a "second" lepton) is reformulated in terms of a space-time distribution of alternative magnetic flux loop-forms. The theory implies a relation between magnetic moment and charge of a lepton and also a relation between the magnetic field of a lepton and the electric Coulomb field. (L.B.S.

Weak

Refer also to abstracts 14428, 15038, and 15039.

15048 NONPERTURBATIVE TREATMENT OF THE LEPTON WEAK INTERACTION. Livshits, M. A. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz., 8: 1245-52(Dec. 1968). (In Russian).

The problem of lepton scattering due to the four-fermion (V – A) interaction is solved in the two-particle approximation on the basis of the axiomatic approach. The obtained scattering cross section at low energies coincides with the first order of the perturbation theory, and decreases at high energies ($E \gg G^{-1/2} \sim 300$ GeV), oscillating between the "unitarity limit" $2\pi\lambda^2$ and zero. (auth)

15049 K_{l4} FORM FACTORS IN CURRENT ALGEBRA WITH HARD PIONS AND KAON. Sarker, A. Q. (International Centre for Theoretical Physics, Trieste, Italy. Univ. of Islamabad, Rawalpindi, Pakistan). Phys. Rev., 176: 1959-70(Dec. 25, 1968).

The axial form factors in K_{l4} decays are calculated using the technique of current algebra, hard kaon and pions, the assumption of partially conserved axial-vector current, and the spectral-function sum rules. The assumption of meson dominance of certain vertex functions and inverse propagators as given by Schnitzer and Weinberg is inherent in such calculations. Taking the parameter ξ from the experimental K_{l3} decays and using the predicted axial-vector form factors at their zero arguments, the decay rates for $K^+ \rightarrow \pi^+\pi^-e^+\nu$ and $K^+ \rightarrow \pi^+\pi^-\mu^+\nu$ are then calculated. On comparison with their recent observed rates, it is found that the value $\xi_{br} = 0.6$ (from the branching ratio) is strongly favored, as opposed to $\xi_{pol} = -1.0$ (from polarization measurements). The values of the form factors for other K_{l4} decays are also given. (auth)

15050 CURRENT ALGEBRA AND THE VECTOR FORM FACTOR IN K_{l4} DECAYS. Sarker, A. Q. (International Centre for Theoretical Physics, Trieste, Italy. Univ. of Islamabad, Rawalpindi, Pakistan). Phys. Rev., 176: 1971-3(Dec. 25, 1968).

The vector form factor in K_{l4} decays is expressed in terms of the known decay rate $\pi^0 \rightarrow 2\gamma$, using the technique of current algebra, hard pions and kaon, and the assumption of partially conserved axial-vector current. Its contributions to the various K_{l4} decay rates are then calculated and its largest value is found to be about 2% that of the axial-vector rate in the case of $K^+ \rightarrow \pi^+\pi^-e^+\nu$ decay. (auth)

15051 STUDY OF THE DECAYS $K \rightarrow l\bar{l}$ AND $K \rightarrow \pi l\bar{l}$. Pais, A. (Rockefeller Univ., New York); Treiman, S. B. Phys. Rev., 176: 1974-8(Dec. 25, 1968).

A general discussion is presented of polarization and angular distributions in the decays $K \rightarrow l\bar{l}$ and $K \rightarrow \pi l\bar{l}$. The main motivation is to examine the ways in which such distributions may reveal the influence of higher-order weak effects as distinct from electromagnetic effects. The relatively most favorable case of the K_L modes is considered. Under the neglect of the small CP impurity in the composition of K_L and K_S states, and of electromagnetic final-state interactions, these modes provide interesting tests for CP and CPT invariance in hitherto unexplored dynamical situations. (auth)

15052 MODEL FOR LEPTONIC INTERACTIONS. II. IS THE PION THE INTERMEDIATE BOSON? Fronsdal, Christian (International Centre for Theoretical Physics, Trieste, Italy). Phys. Rev., 176: 1846-7(Dec. 25, 1968).

A suggestion by Schwinger to use a scalar boson as mediator of weak interactions is combined with a proposal by Nishijima to consider the weak interactions as second-order effects of an in-

teraction with no first-order manifestations. It is then possible to identify the intermediate boson with the pion, although the existence of another spinless boson as an intermediary for weak interactions cannot be ruled out. In either case there is no resonance in high-energy neutrino scattering. If the interaction Lagrangian is odd under PC, then observable PC violation will occur in the third order, with qualitatively correct strength provided that the boson has strong interactions. (auth)

15053 STRUCTURE IN η, $K \rightarrow 3\pi$ DECAY. Kenny, Brian G. (Rutherford High Energy Lab., Chilton, Eng.). Phys. Rev., 176: 1735-8(Dec. 25, 1968).

Some of the consequences of the linear matrix-element and linear spectrum approximations are explored in the decays η, $K \rightarrow 3\pi$. The problem is considered both nonrelativistically and relativistically, assuming that all pions have equal mass. In particular, two different consequences are examined. First, the different implications of the different models are considered for the differential energy spectra. Secondly, it is found that by taking various simple linear combinations of the Dalitz-plot sextants and comparing them, it is possible to make certain "consistency predictions" which are different for the two different models considered and which would enable one to distinguish between the models in a very simple way. (auth)

15054 NUCLEAR EFFECTS ON THE QUASI-ELASTIC NEUTRINO SCATTERING $\nu + n \rightarrow \mu^- + p$. Yao, York-peng (Univ. of Michigan, Ann Arbor). Phys. Rev., 176: 1680-5(Dec. 25, 1968).

A Fermi-gas model is assumed to account for the nuclear effects in the process $\nu + n \rightarrow \mu^- + p$. Various expressions for differential cross sections are derived as analytically as possible to bring out the physical features. The formulation is then used to analyze the preliminary Argonne data. The mass parameter M_A^2 in a dipole fit of the axial-vector form factor of the nucleon is found to be $0.7m_p^2 - 0.9m_p^2$. (auth)

15055 DIVERGENT PART OF THE SECOND-ORDER ELECTROMAGNETIC CORRECTIONS TO THE RATIO G_A/G_V. Sirlin, A. (International Center for Theoretical Physics, Trieste, Italy). Phys. Rev., 176: 1871-80(Dec. 25, 1968).

The divergent part of the second-order electromagnetic corrections to the axial-vector matrix elements is studied. The main tool in this work is a simple extension of the Bjorken limit to the case involving the time-ordered product of three currents (or local operators). Applying this generalization to theories in which all gradient terms are assumed to be c numbers, one finds, in the over-all corrections to the axial-vector matrix elements, logarithmic divergences which are not present (to the same approximation in α) in the Fermi amplitude. These divergences give a vanishing contribution if a relevant double commutator involves only a δ function and if the commutator $[\partial_0 j^\mu(x), j_\mu(0)]$ is a c number, j^μ being the hadronic part of the electromagnetic current. If these two conditions hold, it can be shown, for example, that the second-order corrections to G_A/G_V (in neutron β decay) are finite in the simple intermediate-boson model previously discussed. In the usual case in which $[\partial_0 j^\mu(x), j_\mu(0)]$ is an operator, in general, uncompensated logarithmic divergences are found in the over-all corrections to G_A/G_V with coefficients which appear to be highly model-dependent. The effect of operator gradient terms and the possible connection with the well-known divergences in the electromagnetic mass shifts is discussed. The case of the $SU_3 \otimes SU_3$ algebra of fields is studied separately. Applying the generalization of the Bjorken limit, it is easy to identify in this theory the part of the (divergent) radiative corrections to β decay which is associated with the mass shifts of the charged vector and axial-vector mesons. After this part is removed by a mass renormalization of such mesons, the remaining divergences maintain the chiral structure, are independent of momentum transfer, and amount to one-half the Bjorken correction factor. Thus, by applying the method of this paper, one re dily recovers, in the case of the algebra of fields, Schwinger's ...terpretation of this factor, as well as his expressions for the divergent parts of the mass shifts of the charged vector and axial-vector mesons. It is pointed out that, in the broader context of current algebra, such identification are model-dependent. This is illustrated by examining, on the basis of the approach of this work, the familiar example of muon decay. (auth)

15056 PRODUCTION OF LEPTON PAIRS BY HIGH ENERGY NEUTRINOS IN THE FIELD OF A STRONG ELECTROMAGNETIC WAVE. Choban, E. A.; Ivanov, A. N. (Leningrad Polytechnic Inst.). Zh. Eksp. Teor. Fiz., 56: 194-200(Jan. 1969). (In Russian).

Production of e^-e^+- and $\mu^-\mu^+$-pairs due to scattering of neutrinos in the field of a plane monochromatic electromagnetic wave is considered. Formulas for the probabilities of the processes under consideration are derived for the case when the product of the energy of the original neutrino, expressed in terms of lepton rest energy, by the wave field strength expressed in units of lepton critical field strength is much greater than unity. The analysis is carried out in the limit inverse to the limit of validity of perturbation theory with respect to the external electromagnetic field. (auth)

15057 MODEL OF THE FINITE SELF-MASSES OF LEPTONS. Terazawa, Hidezumi (Tokyo Univ.). Phys. Rev. Lett., 22: 254-5(Feb. 10, 1969).

A model of the weak interactions with scalar intermediate bosons $C^\pm$ with a negative metric in addition to the usual weak vector bosons $B^\pm$ is considered. With this modification, problems of divergence and high-energy behavior are greatly reduced. If the logarithmic weak and electromagnetic self-mass divergences are assumed to cancel each other, the coupling constant g and the mass m_B of the weak boson can be predicted. (auth)

15058 NEAR $\kappa-K$ MASS DEGENERACY AND THE K_{l3} FORM FACTORS. Berman, S. M.; Roy, P. (Stanford Univ., Calif.). Phys. Lett., 28B: 326-9(Dec. 23, 1968).

It is shown how the soft pion theorems on the K_{l3} and K_{l4} matrix elements can be made consistent with the negative values of ξ obtained by the polarization experiments by assuming the existence of a κ-meson with a mass nearly equal to that of the kaon. (auth)

15059 NEUTRINO ASTRONOMY AND LEPTON CHARGE. Gribov, V.; Pontecorvo, B. (Joint Inst. for Nuclear Research, Dubna, USSR). Phys. Lett., 28B: 493-6(Jan. 20, 1969).

It is shown that lepton nonconservation might lead to a decrease in the number of detectable solar neutrinos at the earth surface, because of $\nu_e \rightleftharpoons \nu_\mu$ oscillations, similar to $K^0 \rightleftharpoons \bar{K}^0$ oscillations. Equations are presented describing such oscillations for the case when there exist only four neutrino states. (auth)

15060 TOPICS IN STRONG AND WEAK INTERACTIONS. Moffat, J. W. (Univ. of Toronto). pp 557-601 of High Energy Physics and Fundamental Particles. Barut, Asim O.; Brittin, Wesley E. (eds.). New York, Gordon and Breach, Science Publishers, 1968.

The following topics on strong and weak interactions are discussed: the Regge pole model at high energies, forward pion–nucleon dispersion relations and superconvergence relations; current algebras, sum rules, partial chiral symmetries, and saturation of superconvergence sum rules based on low-lying states. (L.B.S.)

15061 RADIATIVE CORRECTIONS TO FERMI DECAYS AND UNIVERSAL COUPLING OF THE WEAK INTERACTIONS. Norton, Richard E. (Univ. of California, Los Angeles). pp 603-23 of High Energy Physics and Fundamental Particles. Barut, Asim O.; Brittin, Wesley E. (eds.). New York, Gordon and Breach, Science Publishers, 1968.

An attempt is made to calculate the radiative corrections to β-decay and to incorporate the results with the observed decay rates for ^{14}O and for the μ-meson to obtain an assessment concerning the validity of the universal coupling strength for weak interactions. The features of the theory of weak interactions which enter into the question of universality are discussed. The results concerning the properties of the relevant decay rates are listed and the derivations of these results are then outlined. A numerical comparison is given between the value of the Cabibbo angle deduced from K_{e3} decay and the value obtained by including the radiation corrections to the ^{14}O and μ-meson decay rates. The discussion is based on the V–A theory of weak interactions, although the results apply to the theory in which the weak interaction is mediated by a vector meson, as well as to the more conventional theory with a local, current–current interaction. (L.B S.)

15062 MUON CAPTURE. Devanathan, V. (Univ. of Virginia, Charlottesville. Univ. of Madras). pp 625-42 of High Energy Physics and Fundamental Particles. Barut, Asim O.; Brittin, Wesley E. (eds.). New York, Gordon and Breach, Science Publishers, 1968.

The lecture is devoted to one particular aspect of the problem of muon capture, namely, the angular distribution of nuclear recoils and of emitted neutrons. (L.B.S.)

Strong (General)

Refer also to abstracts 15107, 15252, 15265, and 15269.

15063 (COO–1573-49) ELASTIC DIFFRACTION SCATTERING OF HADRONS AT HIGH ENERGIES. Chow, Gee-Yin (Case Western Reserve Univ., Cleveland, Ohio. Dept. of Physics). Jan. 1969. Contract AT(11-1)-1573. 95p. Dep. CFSTI.

Thesis.

A new model for the high energy ($p_{LAB} \geq 4$ (GeV/c)^2 diffraction

scattering of hadrons is presented. This shadow scattering model, quantitatively, explains the magnitude and energy dependence of the widths of elastic scattering diffraction peaks. An improved approximation for the inelastic intermediate states is used which emphasizes the role of quasi-elastic scattering and optical absorption with energy independent opacity. The quasi-elastic scattering is calculated from Feynman diagrams while the optical absorption is constrained by the observed total cross sections. Unitarity and one energy independent scale fixing parameter, then, give quantitative predictions for the widths of diffraction peaks which are only weakly dependent on the assumed l dependence of the optical absorption. (auth)

15064 (ITF-68-34) HIGH ENERGY DIFFRACTION SCATTERING OF HADRONS AND THE QUARK MODEL OF ELEMENTARY PARTICLES INTERACTION. Akhiezer, A. I.; Rekalo, M. P. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1968. 15p. (In Russian). (CONF-680453-2). Dep.

From 2nd Conference on Axiomatical Field Theory and Theory of Elementary Particles, Kiev, USSR.

The high energy diffraction scattering of elementary particles is considered in the framework of the quark model. It is supposed that in the region of momenta of colliding hadrons not larger than 10 Gev/c the antiquark-quark scattering amplitude has two diffraction peaks while the quark-quark scattering amplitude exhibits only the principal diffractive peak. This difference stipulates the appearance of the second diffraction peak in the differential cross sections of the reactions into whose amplitudes the annihilation quark mechanisms make contribution. Such a model presents a simple scheme for answering the question for which processes the diffraction picture should be observed or alternatively be, absent. This scheme enables one to find relations between differential cross sections in the region of the second diffraction peak. The relations between the polarizations of finite particles during the diffraction scattering are obtained; the behavior of polarizations of finite baryons depending on the square of momentum transfer is predicted, as well as the signs of finite baryon polarizations for various reactions. (auth)

15065 HEAVY FUNDAMENTAL PARTICLES. Sitte, K. (Univ., Turin. Univ., Freiburg i. B.). Nuovo Cim., Suppl., 6: 866-86(1968).

A discussion is given of the present situation concerning the proof or disproof of the reality of the heavy fundamental particles including the experimental search for their existence. It is concluded that these heavy fundamental particles, triplets of fractional or of unit charge have as yet not been identified with certainty either as part of terrestrial or stellar matter or as products of high-energy interactions. (J.F.P.)

15066 RELATIVISTIC CORRECTIONS TO NONRELATIVISTIC TWO-PARTICLE DYNAMICAL CALCULATIONS: DEMONSTRATION OF THE VALIDITY OF THE DRELL-HEARN-GERASIMOV SUM RULE FOR WEAKLY BOUND COMPOSITE PARTICLES. Osborn, Hugh (Univ. of Sussex, Brighton, Eng.). Phys. Rev., 176: 1523-33(Dec. 25, 1968).

The problem of the first-order relativistic corrections to the conventional nonrelativistic perturbation treatment of electromagnetic interactions of bound states is discussed. It is shown how the Thomas precession effect is usually mishandled for small excitation energies acting on a bound state. These results are demonstrated by the explicit calculation of the single-particle matrix elements of the charge density and the low-energy Compton scattering amplitude in a simple bound-state model. The amplitudes, which are known by virtue of relativistic invariance and current conservation, are also explicitly calculated, but agreement is obtained only by applying the relativistic modifications of the c.m. variables found in a previous paper. At the same time, the Drell-Hearn-Gerasimov sum rule is shown to be consistent for this model and also for simple models of the hydrogen atom and the deuteron when the constituent particles have arbitrary masses. (auth)

15067 SEARCH FOR STABLE FRACTIONALLY CHARGED PARTICLES. Rank, David M. (Univ. of Michigan, Ann Arbor). Phys. Rev., 176: 1635-43(Dec. 25, 1968).

A search for stable quarks in terrestrial materials was carried out using ultraviolet spectroscopy and an oil-drop technique of charge measurement. The spectroscopy involved a search for the Lyman series of emission lines from hydrogenic atoms formed with a $+\frac{2}{3}$ quark as a nucleus. The oil-drop method attempted to detect $\frac{1}{3}$ integral charges on oil drops approximately 20 μ in dia. Electric fields were used to enrich the samples in quarks and thereby improve the sensitivity of the experiments. The concentration of quarks in the materials examined was determined to be less than 10^{-18} quarks/nucleon for the spectroscopic experiments and less than 10^{-20} quarks/nucleon for the oil-drop experiments. (auth)

15068 EFFECT OF THE EXISTENCE OF AN ELEMENTARY QUARK ON HIGH-ENERGY SCATTERING. Anderson, Stuart D. (Univ. of California, Berkeley). Phys. Rev., 176: 1881-90 (Dec. 25, 1968).

An elementary quark, if supposed to exist and to couple in quark antiquark pairs to ordinary two-particle channels, gives rise to a Regge trajectory which would dominant high-energy scattering at large momentum transfer. A simple model theory embodying these features is presented. Specifically, the model assumes a single scalar-scalar pair to represent the ordinary two-particle channel which is observed, coupled to a spinor-spinor channel of large mass, and simple pole-type potentials approximated in the effective-range method. The Regge trajectory and subtraction generated by this coupling are computed, and arguments are given concerning their contribution to the cross section. Comparison with proton-proton scattering suggests that if such an elementary particle exists, its mass must be greater than about 10 GeV. (auth)

15069 MODEL DEPENDENCE OF THE ASYMPTOTIC BEHAVIOR OF FORM FACTORS FOR RELATIVISTIC COMPOSITE MODELS. Ciafaloni, M. (Scuola Normale Superiore, Pisa, Italy. Istituto Nazionale di Fisica Nucleare, Pisa. Italy). Phys. Rev., 176: 1898-1904(Dec. 25, 1968).

The large-momentum-transfer behavior of the electromagnetic form factors of composite hadrons is shown to be model-dependent Integer-spin bound states are treated in the ladder approximation to the two-body Bethe-Salpeter equation. Both spinless and spin-$\frac{1}{2}$ constituents are considered, interacting through regular or singular renormalizable interactions. It is found that the asymptotic behavior of the form factors depends on the kind of singularity at the origin for the regular interactions and on the coupling constant for the singular ones. This dependence is different for spinless and spin-$\frac{1}{2}$ constituents. For spinless constituents, the form factor vanishes more rapidly than $1/q^2$ in all significant cases, but for spin-$\frac{1}{2}$ constituents it does not; in all cases, however, it vanishes at infinity, and the behavior is better than in the corresponding elementary-particle case. (auth)

15070 BOOTSTRAPS. Diu, B. (CERN, Geneva). pp 143-99 of Methods in Subnuclear Physics. Vol. 2. Nikolic, M. (ed.). New York, Gordon and Breach, Science Publishers, Inc., 1968.

The N/D method for calculating partial wave amplitudes is first discussed. The general bootstrap idea is then described. Two classical examples of practical calculations which try to apply this idea are considered in detail - the ρ bootstrap and the N-N* reciprocal bootstrap. Some examples of qualitative bootstrap considerations are discussed, including various $\pi\pi$ states, strangeness one mesons, KK resonances, the $K\bar{K}$ states, and inclusion of SU_3 symmetry. A brief description is given of the Dashen-Frautschi perturbation method, and applications to the S waves of nonleptonic hyperon decays and to mass differences among the baryon multiplets are discussed. (L.B.S.)

15071 EQUIVALENT-POTENTIAL APPROACH USING THE BETHE-SALPETER AND UNITARITY EQUATIONS. Balazs, Louis A. P. (Univ. of California, Los Angeles). Phys. Rev., 176: 1769-77(Dec. 25, 1968).

A Bethe-Salpeter potential is defined which will reproduce the absorptive part at each energy. The method is a straightforward generalization of the one originally proposed by Charap and Fubini for defining the correct nonrelativistic potential. It is, however, fully relativistic and does not seem to lead to spurious singularities. In practice, an approximate version of the potential is used — one which gives only long-range effects correctly. In addition, the absorptive part is assumed to be dominated by a few narrow resonances; a discussion is given of the differences between such an equivalent potential and a potential given by perturbation theory. The method is applied to a rough calculation of the ρ meson in $\pi\pi$ scattering with the potential constructed from ρ, f^0, and g meson exchange. Experimental values are taken for their masses as well as for the input ρ and f^0 widths. The input g-meson width (which is least well known experimentally) is then adjusted so that the output ρ has the correct mass. This leads to widths of 222 and 175 MeV for the input g and output ρ (compared with experimental values of 170 ± 30 and 125 MeV, respectively). Finally, a purely on-shell technique is discussed which is very similar to the Bethe-Salpeter scheme but may avoid some of its difficulties. (auth)

15072 TWO BODY PROCESSES AT HIGH-ENERGY. Bialas, A. (Jagellonian Univ., Krakow). pp 643-57 of Methods in Subnuclear Physics. ol. 2. Nikolic, M. (ed.). New York, Gordon and Breach, Science Publishers, Inc., 1968.

The high-energy behavior of two-body processes is discussed. The basic experimental features of the low-momentum-transfer two-body reactions are formulated. The coherent character of the interaction at low momentum transfer is briefly discussed. Experimental data and theoretical models for scattering at high momentum transfer are discussed. (L.B.S.)

15073 PHENOMENOLOGICAL MODELS FOR HIGH ENERGY ELASTIC SCATTERING. Bertocchi, L. (CERN, Geneva). pp 569-641 of Methods in Subnuclear Physics. Vol. 2. Nikolic, M. (ed.). New York, Gordon and Breach, Science Publishers, Inc., 1968.

A brief review is given of the present experimental situation and of some theoretical models for the high-energy elastic scattering of strongly interacting particles. Kinematical definitions, the unitary condition, crossing relation, and analyticity properties are discussed in the introduction. Section 2 treats elastic scattering in the forward direction. Small-angle scattering and the diffraction peak are treated in Section 3. The last section deals with large-angle scattering and the backward peak. (L.B.S.)

15074 MULTIPERIPHERAL BOOTSTRAP MODEL. Chew, G. F.; Pignotti, A. (Univ. of California, Berkeley). Phys. Rev., 176: 2112-19(Dec. 25, 1968).

A crude bootstrap model is constructed, based on forward-direction unitarity and the multi-Regge hypothesis. The Pomeranchuk trajectory is generated by iteration of lower-meson trajectories, whose average residue is correlated with average trajectory height. Iteration of the Pomeranchuk turns out to be a small but nonvanishing perturbation that requires the effective average height of the Pomernachuk trajectory to be slightly less than 1. The model yields a two-parameter formula for multiple-production cross sections that agrees satisfactorily with nucleon-nucleon data up to 30 GeV. (auth)

15075 AN INTERPRETATION OF COSMIC-RAY DATE BY SU_3 TRIPLET PARTICLES. Castagnoli, C. (Univ., Turin); Etim, E.; Picchi, P. Nuovo Cim., Lett., 1: 197-200(Jan. 21, 1969).

It is shown that the electromagnetic muon-nucleon interaction cannot explain the experimental observed horizontal air showers of large size ($10^3 < N < 10^5$). It is conjectured that the shower events are the result of a strong interaction and are produced by a particle of mass greater than that of the nucleon. The SU_3 triplet particle is suggested as a strongly interacting candidate, and is found to be in agreement with experimental data. (L.B.S.)

15076 VERTEX FUNCTION, COINCIDENT ZEROS AND LEVINSON'S THEOREM. Visinescu, M. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys., 13: 723-6(1968).

The vertex function is analyzed in the presence of coincident zeros for the functions which appear in the N/D method, and a relation between these zeros and Levinson's theorem is given. Only the elastic scattering of two neutral scalar bosons with mass M is considered. It is assumed that there is a one-particle contribution with mass μ in the intermediate states. (J.F.P.)

15077 EFFECTIVE LAGRANGIANS AT HIGH ENERGY. Guersey, F.; Koca, M. (Middle East Technical Univ., Ankara). Nuovo Cim., Lett., 1: 228-32(Feb. 1, 1969).

It is suggested that the combination of more general current algebras with Regge pole assumptions could lead to the construction of effective Lagrangians valid in the region of high energy and small momentum transfer. Relations between scattering amplitudes in this region can then be derived from a consideration of symmetry groups admitted by such effective Lagrangians. (J.F.P.)

15078 SMALL HADRONIC PARAMETERS AND A PRINCIPLE OF COMPLEMENTARITY FOR BOOTSTRAP MODELS. Chew, Geoffrey F. (Univ. of California, Berkeley). Phys. Rev. Lett., 22: 364-5(Feb. 24, 1969).

It is conjectured that, although no model is capable of explaining its motivating small parameters, an assortment of complementary models collectively may span the entire hadronic S matrix, with all parameters determined. (auth)

15079 EXCHANGE DEGENERACY AND REGGE DIPS. Finkelstein, Jerome (Stanford Univ., Calif.). Phys. Rev. Lett., 22: 362-4(Feb. 24, 1969).

It is shown that exchange degeneracy leads to dips in differential cross sections when trajectories pass through nonsense, wrong-signature values. The proof does not assume the absence of Gribov–Pomeranchuk fixed poles. (auth)

15080 EXTREMAL f–f' MIXING. Suzuki, Mahiko (Tokyo Univ.). Phys. Rev. Lett., 22: 368-9(Feb. 24, 1969).

It is argued that the usual value of the f-f' mixing angle ($\tan\theta = 1\sqrt{2}$) is the extremum value consistent with the flat Pomeranchuk trajectory. This statement is valid in the approximation of neglecting the $t \leq m_\pi^2$ portion of the double spectral function ρ_{st} with $T = 0$ in the t channel at $s \to \infty$. (auth)

15081 COMPOSITENESS CONDITIONS. Kang, Kyungsik (Brown Univ., Providence). pp 245-65 of High Energy Physics and Fundamental Particles. Barut, Asim O.; Brittin, Wesley E. (eds.). New York, Gordon and Breach, Science Publishers, 1968. (NYO-2262TA-162).

An attempt is made to show how the various compositeness conditions come out in a unified manner. Three cases are considered in detail: (i) a soluble model for which the general solution is available; (ii) the S-wave scattering of two spin-zero equal-mass particles in the two-particle approximation; and (iii) several particles with identical quantum numbers. (L.B.S.)

15082 BOOTSTRAP MODEL OF MESONS, BARYONS, AND RESONANCES. Capps, Richard H. (Northwestern Univ., Evanston, Ill.). pp 51-81 of High Energy Physics and Fundamental Particles. Barut, Asim O.; Brittin, Wesley E. (eds.). New York, Gordon and Breach, Science Publishers, 1968.

A bootstrap model, formulated in terms of approximate dispersion relations, that attempts to explain as many as possible of the properties of the lighter hadrons is discussed. A set of self-consistency conditions were derived based on the application of the saturation assumption to fixed-angle dispersion relations. The conditions are satisfied by a set of mesons and baryons whose predicted properties are in very good agreement with experiment. (L.B.S.)

15083 COMPOSITE MODELS OF HADRONS. Lichtenberg, D. B. (Indiana Univ., Bloomington). pp 643-61 of High Energy Physics and Fundamental Particles. Barut, Asim O.; Brittin, Wesley E. (eds.). New York, Gordon and Breach, Science Publishers, 1968.

The difficulties associated with single-field and two-field-quark models in which a baryon is composed of three quarks are pointed out. A two-particle model is considered in which the baryon is composed of a particle of integral spin and a particle of half-integral spin. The integral-spin particle is considered a diquark. The properties of the diquark are examined. Medium-strong mass splittings, electromagnetic mass splittings, and magnetic moments of the baryons are calculated in this model. (L.B.S.)

Strong (Baryon No. = 0)

Refer also to abstract 15127.

15084 (COO-264-471) PARITY CONSTRAINTS IN THE VENEZIANO MODEL. Freund, Peter G. O.; Schonberg, Edmond (Chicago Univ., Ill. Enrico Fermi Inst. for Nuclear Studies. Chicago Univ., Ill. Dept. of Physics). Jan. 1969. Contract AT(11-1)-264. 9p. (EFI-69-1). Dep. CFSTI.

It is shown that to avoid parity doublets, higher terms must be included in a Veneziano type model for scattering or reaction processes involving two or more particles with spin. Superconvergence relations and chiral constraints are discussed.

15085 (ITF-68-53) CURRENT AND FIELD COMMUTATORS, REFERENCE FRAME AND SUM RULES. de Alfaro, V.; Rossetti, C. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1968. 48p. Dep.

A general survey is given over present day views on current algebra, discussing in particular the role of the pion as a quasi-Goldstone particle and the importance of the reference frame in deriving sum rules. A new class of superconvergence-like sum rules is presented which derives from a set of assumptions about field commutators and from Lorentz transformation properties. (auth)

15086 (UCRL-18637) NOTES ON $\pi\pi$ SCATTERING. [PART] I. Yellin, Joel (California Univ., Berkeley. Lawrence Radiation Lab.). Nov. 21, 1968. Contract W-7405-eng-48. 46p. Dep. CFSTI.

A discussion is given of $\pi\pi$ scattering covering isospin, crossing, Bose statistics, partial wave expansion, unitarity and a model for $\pi\pi$ scattering. The properties, asymptotic behavior, poles and zeros, and threshold behavior of $F_\theta(x,y)$ are discussed. Also considered are pole residues, positivity of resonance widths, behavior of $\pi\pi$ resonance widths, and angular behavior at high energies. (J.F.P.)

15087 (UCRL-18664) NOTES ON $\pi\pi$ SCATTERING. II. SUM RULES AND THRESHOLD BEHAVIOR. Yellin, Joel (California Univ., Berkeley. Lawrence Radiation Lab.). Jan. 2, 1969. Contract W-7405-eng-48. 30p. Dep. CFSTI.

The discussion of $\pi + \pi$ scattering in PCAC and current algebra covers the Adler $\pi\pi$ sum rule, the I = 2 superconvergent sum rule, and scattering length relations. Sum rules in the Veneziano model are considered including I = 2 sum rules and the I = 1,0 sum rules. Also considered is the uniqueness of the Veneziano amplitude. (J.F.P.)

15088 INTERFERENCE PHENOMENA IN DECAYS $X \rightarrow \pi\rho$ AND DETERMINATION OF QUANTUM NUMBERS OF THE A_2 MESON. Dubovikov, M. S.; Narodetskii, I. M. (Moscow Physical-Technical Inst.). Yadern. Fiz., 8: 1236-44(Dec. 1968). (In Russian).

The formulae by Chung for determination of quantum numbers of a boson resonance X, whose decay scheme is $X \rightarrow V + \Pi$ are modified so as to be valid for the case in which identical particles are present among the decay products of X. The decay $A_2 \rightarrow \pi\rho$ is considered in detail. It is shown that the angular distributions for $J^P = 1^+$, 2^- and $J^P = 2^+$ have specific properties in the region where the ρ-meson bands are crossed over. (auth)

15089 $A_1 \rightarrow \pi\gamma$, $\pi \rightarrow e\nu\gamma$ DECAYS AND THE CURRENT ALGEBRA. Berezinskii, V. S. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz., 8: 1208-12(Dec. 1968). (In Russian).

The dependence of the $A_1\pi\gamma$ vertex on the pion momentum is found assuming the $\rho - A_1 - \pi$ dominance. The relation obtained is used to calculate the probability of $A_1 \rightarrow \pi\gamma$ and $\pi \rightarrow e\nu\gamma$ decays. The partial width of the $A_1 \rightarrow \pi\gamma$ decay is found to be $(3^{+\frac{1}{2}})\%$ and the absolute value of the ratio γ of the axial decay formfactor to the vector one is found to be $|\gamma| = 2.2^{+\frac{1}{1.3}}$. (auth)

15090 SCALAR NONET, SEMILEPTONIC K DECAYS, AND SPECTRAL-FUNCTION SUM RULES. DuttaRoy, Binayak; Martin, Alexander (Stevens Inst. of Tech., Hoboken, N. J.). Phys. Rev., 176: 1979-81(Dec. 25, 1968).

It is shown that if one takes $\epsilon(700)$, the broad isoscalar s-wave dipion resonance for which there exists considerable evidence, along with the as yet not firmly established $\eta_v(1071)$ and $\pi_v(1016)$ and a K_v (perhaps the one at 1080), as forming a scalar nonet, then the widths and branching ratios for the decay of these resonances into two pseudoscalar mesons are quite consistent with observation. In addition, the mixing of ϵ and η_v explains the puzzling smallness of the branching ratio $(\eta_v \rightarrow \pi\pi)/(\eta_v \rightarrow K\bar{K})$, and simultaneously accounts for the K_{e4} axial-vector form factors. Finally, these scalar resonances are found to fit quite well in the framework of current algebra and spectral-function sum rules stemming from SU(3)⊗SU(3) symmetry. (auth)

15091 ARGAND-DIAGRAM LOOPS AND REGGE POLES. Collins, P. D. B.; Johnson, R. C.; Ross, G. G. (Univ. of Durham, Eng.). Phys. Rev., 176: 1952-9(Dec. 25, 1968).

The way in which a crossed-channel Regge pole can produce loops in the Argand diagrams of direct-channel partial waves is examined. It is shown that combinations of trajectories can produce loops which rotate in either direction when the energy is increased. It is argued that these loops do not correspond to resonance poles, but are the effect of oscillations of the crossed-channel discontinuity on the partial-wave amplitudes. The partial-wave projections of Regge fits to $\pi^\pm p$, $K^\pm p$, pp, and $p\bar{p}$ are examined and loops are found in all these processes, including K^+p and pp, which are not known to have any resonances. It is concluded that the existence of these loops should make one cautious about interpreting all the loops found in recent πN phase-shift analyses as resonance poles. (auth)

15092 MULTI-PION SYSTEMS. DECAY OF TWO- AND THREE-PION RESONANCES. Svensson, B. E. Y. (Univ. of Lund, Sweden). pp 341-409 of Methods in Subnuclear Physics. Vol. 2. Nikolic, M. (ed.). New York, Gordon and Breach, Science Publishers, Inc., 1968.

The quantum mechanical description of the production and decay of unstable particles is first considered. A rather complete theoretical treatment is given of the decay of two- and three-pion resonances, assuming that the decays obey all conservation laws of the strong interaction. (L.B.S.)

15093 CP VIOLATION AND COHERENT DECAYS OF KAON PAIRS. Lipkin, Harry J. (Princeton Univ., N. J.). Phys. Rev., 176: 1715-18(Dec. 25, 1968).

The possible experimental use of correlations between two neutral-kaon decays is discussed. Kaon pairs produced either in proton-antiproton annihilation from an s state or in φ decay are in a p wave, which is forbidden by Bose statistics for identical bosons. The observance of a particular decay mode, i.e., $\pi^+\pi^-$, for one kaon implies that the other kaon is forbidden to decay at the same time in this mode. Thus a kaon beam can be constructed that is just that coherent linear combination of K_S and K_L whose amplitudes for decay into this mode cancel one another. The existence of $\Delta I = \frac{3}{2}$ transitions leading to the I = 2 final state in K^0 decay can be tested by looking for double decays where one of the kaons decays into $\pi^+\pi^-$ and the other into $\pi^0\pi^0$. This double decay is allowed at the same time only if both $\Delta I = \frac{1}{2}$ and $\Delta I = \frac{3}{2}$ amplitudes are present in the kaon decay. Detailed calculations and experimental implications are discussed. (auth)

15094 PROTONIUM ANNIHILATION. Vandermeulen, J. (Univ., Liege). pp 411-46 of Methods in Subnuclear Physics. Vol. 2. Nikolic, M. (ed.). New York, Gordon and Breach, Science Publishers, Inc., 1968.

The results obtained in the study of proton-antiproton annihilation at rest in liquid hydrogen are examined. In the first section, a review of the current results is made, pointing out the general properties of the reaction, a compilation of annihilation rates is given and a few comments touch on theoretical interpretation. The second section is devoted to the question of capture for annihilation from S-states of the protonium. First, a short account of the moderation and absorption of slow, negative, strongly interacting particles in liquid hydrogen is presented; second, the direct test of s-capture performed in a particular annihilation channel is described. In the third section, several annihilation modes are examined in some detail and the methods used for identification of various channels are introduced. (L.B.S.)

15095 REGGE POLE THEORY FOR EXPERIMENTALISTS. Hoegaasen, H. (CERN, Geneva). pp 659-95 of Methods in Subnuclear Physics. Vol. 2. Nikolic, M. (ed.). New York, Gordon and Breach, Science Publishers, Inc., 1968.

The first section gives the basic formalism and physical ideas of the Regge-pole model. Regge pole fits to total cross sections and small-angle differential cross sections are treated for πp, Kp, $\bar{p}p$, $\bar{p}n$, and pn interactions. Polarization in πN interactions is studied. The last section discusses the Regge pole treatment of inelastic processes. References are given for further study. (L.B.S.)

15096 UNIVERSAL COUPLING OF THE ω MESON AND REGGE RESIDUES. Banerjee, M. K.; Levinson, C. A. (Univ. of Maryland, College Park). Phys. Rev., 176: 2140-6(Dec. 25, 1968).

Some of the experimental data bearing on the hypothesis of universality of ω coupling are considered. The low-energy data on the coupling of the ω meson and the high-energy data on the coupling of the ω-type Regge trajectory were considered. The data seem to support the universality hypothesis. The universal ω coupling constant $g_\omega^2/4\pi$ is estimated to be 4.96 ± 1.24, which is higher than the universal ρ coupling constant $g_\rho^2/4\pi = 2.60 \pm 0.68$, where g_ρ and g_ω are so normalized that $g_\omega = g_\rho$ in the SU(6) limit. To replace the Regge residues of vector trajectories to the universal coupling constant, the angular momentum dependence of the former is factored out and a "reduced" Regge residue and a scale parameter were introduced for each trajectory. The scale parameters for the ω and the ρ trajectories turn out to be of the order of 290 and 186 MeV, respectively. (auth)

15097 BOOTSTRAP OF MESON TRAJECTORIES FROM SUPERCONVERGENCE. Ademollo, M. (Harvard Univ., Cambridge, Mass.); Rubinstein, H. R.; Veneziano, G.; Virasoro, M. A. Phys. Rev., 176: 1904-25(Dec. 25, 1968).

The reactions $\pi\pi \rightarrow \pi\omega(1^-)$, $\pi\pi \rightarrow \pi A_2(2^+)$, and $\pi\pi \rightarrow \pi\omega_3(3^-)$ are studied as a bootstrap system for natural-parity trajectories. The solution of the previous work is considered, that gave, among other results, expressions for the trajectory and residue functions as well as mass formulas, in agreement with experiment. The sum rules are studied in detail as a function of momentum transfer t. A set of residue functions $\beta(t)$ is found that is self-consistent and such that the Regge and resonance sides of the equations are almost equal in a large region of t. Also a step-by-step approximation is studied that, at each stage, enlarges the region where the equations are valid. It is found, however, that the leading Regge trajectories, even if infinitely rising, cannot bootstrap themselves. Two possible (not incompatible) ways of implementing the bootstrap are outlined. The first way demands an optimized choice of the cutoff parameter and considers the whole family of reactions $\pi\pi \rightarrow \pi X_J$ (X_J being a normal-parity state of spin J). The results for $J \leq 3$ show that this is a definite possibility. The second way is to consider a whole family (parent and daughters) as participating in the bootstrap. This possibility is also found attractive, and as a consequence it is found that daughters must be parallel to the parent for linear trajectories. The properties of the parametrization are also discussed—in particular, the Khuri paradox and the coupling of high-spin resonances to the system. The results are also compared with experiment whenever possible. The A_2 trajectory, for instance, follows the Gell-Mann mechanism, and the exponential t dependence of the

residue functions is perfectly consistent with the one found in recent phenomenological fits to inelastic reactions. (auth)

15098 MESON BOOTSTRAPS FOR UNNATURAL-PARITY STATES. Bishari, M.; Rubinstein, H. R.; Schwimmer, A.; Veneziano, G. (Weizmann Inst. of Science, Rehovoth, Israel). Phys. Rev., 176: 1926-31(Dec. 25, 1968).

The possibility of bootstrapping the unnatural-parity meson states, using finite-energy sum rules, is studied. Previous work on this bootstrap scheme was confined to natural-parity states. A large number of sum rules involving particles which are not firmly established is found with results that are in good agreement with experiment (10%). The equations, though not mathematically consistent, are such that the two sides (Regge and resonances) are equal when t is varied over a large region, and several mass formulas are found including $m_{f_1}^2 = 2m_D^2 - \frac{3}{2}m_\pi^2$, $m_B = m_{A_1} - m_\pi$, $2m_B^2 = 0.5\ BeV^2 + 2m_D^2 + m_\omega^2 + m_\pi^2$, and relations between coupling constants. (auth)

15099 O(4) SYMMETRY, $N\bar{N}$ SCATTERING, AND THE REGGE TRAJECTORY OF THE PION. Lipinski, H. M.; Snider, D. R. (Univ. of California, San Diego, La Jolla). Phys. Rev., 176: 2054-73(Dec. 25, 1968).

The $N\bar{N}$ Bethe-Salpeter equation is studied exploiting the O(4) symmetry of the scattering amplitude at t = 0. Spinor O(4) spherical harmonics are developed and used in the projection of the Bethe-Salpeter equation both at t = 0 and for small finite t. With the choice of Toller quantum number M = 1 for the pion trajectory at t = 0, as seems to be implied by high-energy data, it is found that the M = 1 trajectory must mix with another trajectory near t = 0 in order to produce a physical pion. In addition, O(4) expansions are given for the $N\bar{N}$ helicity amplitudes for both equal and unequal mass. (auth)

15100 CONSTRUCTION OF THE $\pi\pi$ SCATTERING AMPLITUDE FROM SUPERCONVERGENCE. Schmid, C. (CERN, Geneva). Phys. Lett., 28B: 348-52(Dec. 23, 1968).

Assuming Regge trajectories fall linearly for negative t, superconvergence relations are formulated at infinitely many discrete t values. These are saturated with an infinite number of resonances; but only a finite number is involved at each finite t. Assuming the spacing in the grid $\Delta s = \Delta t = (\alpha')^{-1}$ a solution is constructed, which turns out to be the Veneziano formula. Duality is not used as an input, it comes out as a consequence. (auth)

15101 RELATIVISTIC QUARK MODEL FOR MESONS AND THE WEISSKOPF–VAN ROYEN PARADOX. Smith, C. H. Llewellyn (CERN, Geneva). Phys. Lett., 28B: 335-8(Dec. 23, 1968).

Non-relativistic internal motion of the quark-antiquark system does not necessarily imply a non-relativistic spinor structure. A model with a relativistic spinor structure successfully describes meson annihilation processes; large symmetry breaking according to an essentially arbitrary prescription is required to obtain these results using the usual model. (auth)

15102 SCALAR DENSITY TERMS, $K\pi$, AND KK SCATTERING LENGTHS, AND A SYMMETRY-BREAKING PARAMETER. Griffith, Richard W. (California Inst. of Tech., Pasadena). Contract AT(11-1)-68. Phys. Rev., 176: 1705-8(Dec. 25, 1968).

An estimation of s-wave $K\pi$ and KK scattering lengths is made, and a discussion is given of the relation of these quantities to scalar density matrix elements and the relevant symmetry-breaking parameter. (auth)

15103 INTERFERENCE, MIXING, AND ANGULAR CORRELATIONS IN DECAYS OF BOSON RESONANCES. Lipkin, Harry J. (Princeton Univ., N. J.). Phys. Rev., 176: 1709-14(Dec. 25, 1968).

Two new features of boson resonance are discussed. (1) Interference and mixing in decays of different bosons having common decay channels, an (2) competition between partial-wave amplitudes when more than one is allowed. Several examples are considered. Interference between $f^0 \to K\bar{K}$ and $A_2^1 \to K\bar{K}$ is discussed. The axial-vector nonets are discussed in detail, as well as the application to higher-spin resonances. (auth)

15104 VECTOR DOMINANCE AND $\omega-\varphi$ MIXING. Cordes, J. G.; O'Donnell, P. J. (Univ. of Toronto). Nuovo Cim., Lett., 1: 107-10(Jan. 11, 1969).

Predictions for vector-meson decay widths and the mixing angle are obtained using the current-mixing model and vector dominance, and are compared with experiment. (L.B.S.)

15105 CURRENT ALGEBRA AND VENEZIANO'S AMPLITUDE. Savoy, C. A. (Univ., Padua). Nuovo Cim., Lett., 1: 263-6(Feb. 11, 1969).

The consequences arising from a comparison between Veneziano's formula and current algebra results are discussed. In this way a determination of the rho and f partial widths is obtained in good agreement with experiment. It is found that there is a surprising consistency of Veneziano's formula with the successful algebra of currents results when applied to $\pi-\pi$ scattering. (J.F.P.)

15106 RESIDUES OF DAUGHTER TRAJECTORIES. Taylor, J. C. (Oxford Univ.). Phys. Lett., 28B: 501-2(Jan. 20, 1969).

Factorization constrains the residues of daughter Regge poles in equal-unequal mass reactions, in a way which is inconsistent with the simplest ρ bootstraps in $\pi\pi \to \pi\omega$ and $\pi\pi \to \eta\rho$. (auth)

15107 NON-SYMMETRIC NON-RELATIVISTIC QUARK MODEL OF THE BOSONS. Uretsky, Jack L. (Argonne National Lab., Ill.). pp 663-4 of High Energy Physics and Fundamental Particles. Barut, Asim O.; Brittin, Wesley E. (eds.). New York, Gordon and Breach, Science Publishers, 1968.

A description is given of the construction of a simple quark model and of the predictions obtained on the boson mass spectrum, strong decays, quark-pion coupling constant, quark magnetic moment, $\pi^+-\pi^0$ and $\rho^+-\rho^-$ mass differences. (L.B.S.)

15108 REMARKS ON THE HIGH-MOMENTUM PROPERTIES OF TIME-ORDERED V AND A CURRENTS. Grotch, H.; Kazes, E. (Pennsylvania State Univ., University Park). Nuovo Cim., 59A: 444-52(Feb. 21, 1969).

Assuming a high-momentum equality of certain time-ordered products of vector and axial vector currents between low-lying states, several interesting results are obtained. Matrix elements between vacuum states lead to Weinberg-type sum rules previously obtained by others. Application to matrix elements between the vacuum and the ρ^+-meson leads to information on the isovector form factors of the ρ^+. (auth)

15109 SYMMETRIES IN $N\bar{N}$ ANNIHILATIONS. Shpiz, J. M. (City Coll., New York). pp 203-12 of High Energy Physics and Fundamental Particles. Barut, Asim O.; Brittin, Wesley E. (eds.). New York, Gordon and Breach, Science Publishers, 1968.

The consequences of various unitary symmetries for the nucleon–antinucleon annihilations are reviewed. In particular the SU(3), Su(6), U(6,6) and a quark rearrangement model are discussed. It is concluded that none of the higher symmetries discussed can alone provide a complete description of the annihilation process; however, the U(6,6) results for the three-meson annihilations, which coincide with the quark rearrangement theory results, may be used as a basis for a phenomenological description. (L.B.S.)

Strong (Baryon No. = 1)

Refer also to abstracts 14985, 15017, 15091, 15092, 15095, 15202, and 15204.

15110 (COO-264-472) A VECTOR MESON INTERACTION HAMILTONIAN. Kyriakopoulos, E. (Chicago Univ., Ill. Enrico Fermi Inst. for Nuclear Studies. Chicago Univ., Ill. Dept. of Physics). Jan. 1969. Contract AT(11-1)-264. 20p. (EFI-69-3). Dep. CFSTI.

The vector mesons are described in terms of the antisymmetric second rank tensor field $T_{\mu\nu}$. The vector mesons–baryons interaction Lagrangian. $L_{Int} = \frac{1}{2}\, g_1 \bar{B}\sigma_{\mu\nu}\bar{T}_{\mu\nu}B + ig_2\bar{B}\gamma_\nu\partial_\mu\bar{T}_{\mu\nu}\bar{B} = \frac{1}{2}J_{\mu\nu}T_{\mu\nu} + J_\nu\partial_\mu T_{\mu\nu}$ gives the following interaction Hamiltonian, in the interaction representation. $\mathcal{H}_{Int} = L_{Int} + \frac{1}{4}[(1/m_T^2)J_{\mu\nu}J_{\mu\nu} + 2J_\mu J_\mu] + \frac{1}{2}[(1/m_T^2)J_{\mu p}J_{\mu\sigma} + J_p J_\sigma]\eta_p\eta_\sigma$. The normal dependent terms which appear in the S-matrix vanish to any order in perturbation theory, and S-matrix elements can be calculated by using the effective interaction Hamiltonian $(\mathcal{H}_{Int})_{eff} = -L_{Int} + \frac{1}{4}[(1/m_T^2)J_{\mu\nu}J_{\mu\nu} + 2J_\mu J_\mu]$. (auth)

15111 (ITF-68-32) RESONANCE SOLUTIONS OF EQUATIONS FOR πN-SCATTERING. Lend'el, V. I.; Marina, D. M. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1968. 16p. (In Russian). (CONF-680453-7). Dep.

From 2nd Conference on Axiomatical Field Theory and Theory of Elementary Particles, Kiev, USSR.

The resonance solutions of the dispersion equations for P_{11} and P_{33} partial waves are obtained. The account for the short-wavelength interaction allows one to avoid cutting off dispersion integrals. The possibility of interpreting the nucleon as a bound state of πN-system is considered. (auth)

15112 (MIT-2098-509) EQUAL TIME COMMUTATORS AND LOW ENERGY PION PHYSICS. de Alfaro, V.; Fubini, S.; Furlan, G.; Rossetti, C. (Massachusetts Inst. of Tech., Cambridge. Lab. for Nuclear Science). Jan. 1969. Contract AT(30-1)-2098. 23p. (DSR-77906). Dep. CFSTI.

A general formalism is discussed where physical pion amplitudes at low energy are expressed in terms of equal time com-

mutators of current algebra and field algebra plus a dispersion like sum over intermediate states. This result generalizes a previous treatment valid for pions at rest. Some features of the approach are examined. (auth)

15113 PRODUCTION OF ρ MESONS IN πN COLLISIONS AND THE HYPOTHESIS OF ρ-MESON COUPLING TO THE CONSERVED CURRENT. Achasov, N. N.; Samkov, L. M. (Inst. of Mathematics and Computer Center, Novosibirsk, USSR). Yadern. Fiz., 8: 1201-7(Dec. 1968). (In Russian).

In the framework of the one-pion exchange (OPE) model the ρ-meson emission by the nucleon is taken into account in agreement with the hypothesis of the ρ-meson coupling to the conserved isovector vector current. Angular distribution of the decay pions for the reaction $\pi^-p \to \rho^-p$ is investigated and compared with the experiment at the incident pion momentum 2.7 and 3 GeV/c. It is shown that the presented model agrees with experiment no worse than the OPE model with absorption. A possibility to fit the cross section $d\sigma/dt$ to the experiment introducing a formfactor F(t) is discussed. (auth)

15114 REPRESENTATION MIXING AND SU_3 SYMMETRY BREAKING IN THE $\frac{1}{2}^-$ BARYON OCTET. Dobson, Peter N. Jr. (Univ. of Hawaii, Honolulu). Phys. Rev., 176: 1757-62(Dec. 25, 1968).

Widths and coupling-constant products are obtained for members of the $\frac{1}{2}^-$ baryon resonance octet by fitting the η-production data near threshold with a direct-channel resonance model. An interpretation of the fitted parameters in terms of representation mixing is shown to lead to large singlet-octet and decuplet-octet mixing. Quark-model modifications of the vertices, as proposed by Mitra and Ross, are also considered, with much the same results. An alternative interpretation in terms of an SU_3 symmetry-breaking interaction based on a suggestion by Pakvasa is given. (auth)

15115 MESON–BARYON AND BARYON–BARYON SCATTERING IN REGGEIZED U(6)⊗U(6) THEORY. Delbourgo, R.; Harun-ar-Rashid (International Centre for Theoretical Physics, Trieste, Italy). Phys. Rev., 176: 2074-81(Dec. 25, 1968).

A complete set of rules is presented for evaluating the master meson-trajectory exchange contribution to high-energy scattering between mesons (M) and baryons (B) in U(6)⊗U(6) theory. The practical implementation of these rules is illustrated in considerable detail for quark-quark scattering as well as for the 35_w-exchange contribution to MB and BB charge-exchange amplitudes. (auth)

15116 REGGE-POLE EIKONAL THEORY OF SMALL-ANGLE PION–NUCLEON SCATTERING. Arnold, Richard C.; Blackmon, Maurice L. (Argonne National Lab., Ill.). Phys. Rev., 176: 2082-5(Dec. 25, 1968).

A quantitative model for high-energy, small-momentum-transfer pion-proton elastic scattering and charge-exchange data (both differential cross sections and polarizations) is presented. The model is based on P′ and ρ Regge poles in the optical potential, together with a Pomeranchon whose residue is proportional to the product of electromagnetic form factors of pion and proton. Features not present in the Regge-pole approach, such as the crossover effect and nonzero charge-exchange polarization, appear automatically in this model. Specific properties of our ρ and P′ poles are: (a) both choose nonsense; (b) constant reduced residues; (c) linear trajectories; (d) zero helicity flip for P′; and (e) helicity-nonflip P′ residue given by exchange degeneracy (and symmetry, e.g., from quark model) in terms of ρ residue. The elastic scattering fit is satisfactory for all momenta greater than 6 GeV/c and all squared momentum transfers less than 0.5 GeV^2/c^2. All available charge-exchange data above 5 GeV/c are fitted well, as are total cross sections and real parts of amplitudes in the forward direction. (auth)

15117 SUPERCONVERGENCE RELATIONS AND POSSIBLE NEW RESONANCES IN PION–BARYON SCATTERING. Kiang, D. (Dalhousie Univ., Halifax, Nova Scotia); Lin, W. C.; Sugano, R.; Lin, H. E.; Nogami, Y. Phys. Rev., 176: 2159-62(Dec. 25, 1968).

Superconvergence relations for the $B^{(+)}$ amplitudes at t = 0 for pion-baryon scattering are well saturated by low-lying resonances, except for the one for the π-Σ scattering. This remarkable disparity suggests that some new π-Σ resonances may exist. From the unitarity condition on the p-wave π-Σ scattering, it is shown that the resonances, if any, are in $(I,J^P) = (0,\frac{3}{2}^+)$ and $(2,\frac{3}{2}^+)$ states. (auth)

15118 DECK-MODEL CALCULATION FOR DOUBLY CHARGED K $\pi\pi$ SYSTEMS IN KN → K* πN REACTIONS. Bomse, F.; Moses, E. J. (Vanderbilt Univ., Nashville). Phys. Rev., 176: 2163-5(Dec. 25, 1968).

A Deck-model calculation for doubly charged K*π systems in KN → K*πN reactions was performed. The resulting K*π mass spectra show obvious low-mass enhancements. If the recent remarks of Chew and Pignotti apply to this calculation, these enhancements should be interpreted as evidence for resonance behavior in doubly charged K*π systems. (auth)

15119 CRITIQUE OF EMPIRICAL MASS FORMULA FOR BARYONS. Saleem, Mohammad (Univ. of the Punjab, Lahore). Phys. Rev., 176: 2166-7(Dec. 25, 1968).

The significance of the mass formula of French et al. is investigated. It is shown that any relation of the type $M = a + M_0 n(n+1)$ with different suitable choices of the constants a and M_0 will give the masses of the baryons, provided gaps in several of the sequences are allowed, as has been done by French et al. (auth)

15120 CAN THE PARITY OF THE Ω^- BY MEASURED? Kane, G. L. (Univ. of Michigan, Ann Arbor); Moravcsik, Michael J. Phys. Rev., 176: 1733-4(Dec. 25, 1968).

The Ω^- is unusual in that it can only decay weakly, and in that, for purposes of measuring its parity, it can only be produced in reactions with (at least) three-body final states. These circumstances imply that, with one possible exception, it may be so difficult to measure the parity of the Ω^- that such a measurement is a practical impossibility for some time to come. (auth)

15121 RESCATTERING EFFECTS IN THE QUARK MODEL FOR MESON–BARYON COUPLINGS. Anand, J. D.; Bhasin, V. S.; Mitra, A. N. (Univ. of Delhi). Phys. Rev., 176: 1891-7(Dec. 25, 1968).

The eikonal approximation in high-energy scattering is used as a basis for the evaluation of scattering corrections to meson–baryon couplings in the independent quark model. These corrections, which reduce the SU(6) symmetry (characteristic of the impulse approximation) to a mere SU(3) symmetry, are found to be typically of the order of 20–30% on the coupling constants. An important part of the correction, which arises from the purely "SU(3)-isotropic" component of the meson-quark amplitude, has exactly the same structure as the SU(6)-invariant couplings and hence can be interpreted as a renormalization effect. The remaining corrections, which may be called the "true scattering effects," lead to an explicit formula for the F/D ratio in octet couplings in terms of the meson-quark scattering parameters which differs from its SU(6) value of $\frac{3}{2}$ by about 4%. These corrections also give an enhancement factor for decuplet decays which increases the predicted rate for N* → Nπ by about 30%. It is argued that the nature of these numerical results is rather insensitive to the precise validity or lack of validity of the eikonal approximation. (auth)

15122 CHIRAL LAGRANGIAN CALCULATION OF PION–NUCLEON SCATTERING LENGTHS. Peccei, R. D. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Phys. Rev., 176: 1812-21(Dec. 25, 1968).

Two chiral-invariant Langrangian models of pion-nucleon scattering are considered. Weinberg's model, which contains a direct pion-nucleon scattering term, and an extension of Schwinger's model in which this direct term is replaced by a ρ-mediated term, is described. These models have been extended by including a πNN* (1236) interaction. This has allowed the N* contributions to the S-wave pion-nucleon scattering lengths to be calculated and the P-wave scattering lengths to be computed. The theoretically obtained values for these scattering lengths are found to be in reasonable agreement with experiment, with the possible exception of the $a^-_{P_{\frac{1}{2}}}$ scattering length, for which only the direct model gives agreement with the present experimental data. For the a^+_S scattering length, agreement was obtained only after the introduction of a contact term. The presence of such a term is made more plausible by the study of the asymptotic behavior of the isospin-even amplitudes. The analysis was also compared with similar current-algebra calculations and over-all agreement was obtained, especially with the ρ-exchange model, although the results differ from these calculations in various details. (auth)

15123 COMPLEX $\bar{K}N$ SCATTERING LENGTHS AND CURRENT ALGEBRA. Basu, Debabrata; Biswas, S. N.; Datta, K. (Univ. of Delhi). Phys. Rev., 176: 1835-41(Dec. 25, 1968).

The real and imaginary parts of the s-wave $\bar{K}N$ scattering length in the I = 0 channel are calculated, starting from the predictions of soft-meson current algebra. The multichannel ND^{-1} formalism is used to unitarize the amplitudes obtained from current algebra. Dynamical off-mass-shell corrections are isolated in certain residues for one-pole approximations to the numerator functions. These residues, for which assumptions of smooth extrapolation are made, are obtained by comparing the unitarized amplitudes with the results of current algebra. The coupling of

the $\bar{K}N$ to the $\pi\Sigma$ channel, which has a lower threshold, generates the imaginary part of the scattering length with the correct sign and reverses the (incorrect) sign of the real part. The magnitudes of the real and imaginary parts agree well with the results of recent experiments and are consistent with the existence of the Y_0^* (1405) virtual bound state below the $\bar{K}N$ threshold. (auth)

15124 UNITARITY–ANALYTICITY EQUATIONS FOR ELASTIC PION–NUCLEON SCATTERING: A NUMERICAL SOLUTION. Boccio, John R. (Swarthmore Coll., Pa.). Phys. Rev., 176: 1934-44(Dec. 25, 1968).

Using the elastic unitarity approximation together with Mandelstam analyticity and the crossing principle, an approximation scheme was devised within the framework of the elastic pion-nucleon scattering problem. A set of four coupled linear integral equations for the imaginary parts of the u-channel absorptive parts was constructed. Regge asymptotic behavior was assumed. A crude numerical analysis of the equations was carried out. The results were very encouraging in that output trajectories were produced which rise to values of $\mathrm{Re}\alpha_\Delta(u) \approx 3/2$ and possess a shape which resembles the conventionally assumed form. (auth)

15125 INTERFERENCE OF RESONANCES. Wolters, G. F. (Zeeman Lab., Amsterdam). pp 447-92 of Methods in Subnuclear Physics. Vol. 2. Nikolic, M. (ed.). New York, Gordon and Breach, Science Publishers, Inc., 1968.

The first chapters give a summary of some elements of the helicity formalism with application to resonance disintegration. Elastic resonance excitation and interference effects are treated in chapter II. The special case of collisions between spinless and spin-1/2 particles are discussed; the reaction $K^-p \rightarrow Y_1^*(1520) \rightarrow \Sigma^+\pi^-$ is considered as an example. Some remarks are given in chapter III on interference when two resonances can be produced simultaneously. (L.B.S.)

15126 CROSSING SYMMETRIC REGGE BEHAVED AMPLITUDE FOR πN SCATTERING. Igi, K. (CERN, Geneva). Phys. Lett., 28B: 330-4(Dec. 23, 1968).

The crossing symmetric Regge behaved amplitude for pion–nucleon scattering is constructed. This model favors the Gell–Mann ghost-eliminating mechanism for both the ρ and P′ trajectories. Several predictions agree with experiment. An approach for determining the P′ parameters is also proposed. (auth)

15127 LARGE-ANGLE p–p SCATTERING, CERULUS–MARTIN BOUND AND THE VENEZIANO MODEL. Cassandro, M. (Istituto Nazionale di Fisica Nucleare, Rome. Univ., Rome); Greco, M. Nuovo Cim., Lett., 1: 181-6(Jan. 21, 1969).

The Veneziano model for a crossing symmetric relativistic scattering amplitude is used to investigate the differential cross sections for large-angle p–p and $\bar{p}$–p interactions at large momentum transfers. The results are in agreement with experiment. (L.B.S.)

15128 A PHENOMENOLOGICAL MULTIPARTICLE AMPLITUDE WITH REGGE TRAJECTORIES IN s AND t CHANNELS. Plahte, E.; Roberts, R. G. (CERN, Geneva). Nuovo Cim., Lett., 1: 187-91(Jan. 21, 1969).

A Reggeized multipheral model proposed by Chan et al. (Nuovo Cimento, 57A: 93(1968)) is modified and applied to the $\pi^+p \rightarrow (n-1)\pi N$ interaction. The modification enables the model to accurately describe the Van Hove overlap function and gives a good estimate for the shadow elastic scattering. (L.B.S.)

15129 SELF-CONSISTENCY CONDITIONS FOR AN INELASTIC AMPLITUDE AND FOR COUPLING CONSTANTS. Barut, A. O.; Uenal, B. C. (International Centre for Theoretical Physics, Trieste, Italy). Nuovo Cim., Lett., 1: 145-9 (Jan. 21, 1969).

It is shown that when the gauge condition is applied to production processes, new consistency conditions on the coupling constants are obtained which are not present in the elastic case. The P_{11} production amplitude in π–N interactions is considered. The method can also be applied to the Compton effect and photoproduction of resonant states. (L.B.S.)

15130 EXCHANGE DEGENERACY FROM FESR AND THE Y*-RESONANCES. Schmid, C. (CERN, Geneva). Nuovo Cim., Lett., 1: 165-8(Jan. 21, 1969).

An experimental test is made of the FESR bootstrap scheme prediction that Y* resonances as observed in $\bar{K}N \rightarrow \bar{K}N$ interactions are exchange degenerate in mass and coupling strength. (L.B.S.)

15131 LADDER APPROXIMATION IN PARTIAL-WAVE DISPERSION RELATIONS. Gutbrod, F. (Deutsches Elektronen-Synchrotron, Hamburg). Nuovo Cim., 59A: 293-302(Jan. 21, 1969).

The left-hand cut of the 3/2, 3/2 π–N partial-wave amplitude is calculated by iterating the Bethe–Salpeter equation with nucleon exchange including a smooth cut-off. The partial-wave dispersion relation is approximately satisfied, if the cut-off is chosen properly. The magnetic-dipole excitation of the isobar as well as the transition form factor is determined through a dispersion sum rule retaining only a class of ladder diagrams. (auth)

15132 A POSSIBLE EXPLANATION FOR THE EXISTENCE OF THE FORWARD PEAK IN THE REACTION $\pi + N \rightarrow \rho + \Delta$. Nath, L. M.; George, D. J. (Purdue Univ., Lafayette, Ind.). Nuovo Cim., Lett., 1: 111-12(Jan. 11, 1969).

The theory of conspiracy and factorization of residues predicts a forward dip in the $\pi + N \rightarrow \rho + \Delta$ interaction, but a forward peak is observed experimentally. It is attempted to solve this paradox by neither abandoning conspiracy nor factorization of residues, but instead, abandoning the idea that a particle can only be involved in one class of conspiracy. (W.H.K.)

15133 DISPERSION-THEORETIC DERIVATION OF THE PCAC CONSISTENCY CONDITION AND ρ-DOMINANCE IN π N SCATTERING. Banerjee, H.; Millik, S. (Saha Inst. of Nuclear Physics, Calcutta). Nuovo Cim., Lett., 1: 87-91(Jan. 11, 1969).

The PCAC consistency condition for the isospin-even amplitude and the ρ-dominance in π N scattering are derived within the framework of on-shell dynamics, using unsubtracted dispersion relations. (L.B.S.)

15134 ASYMPTOTIC BEHAVIOR OF THE $B^\pm$ SPIN-FLIP πN AMPLITUDES. Grecchi, V. (Univ., Florence. Scuola di Perfezionamento, Bologna); Minguzzi, A.; Salvini, M. Nuovo Cim., Lett., 1: 267-70(Feb. 11, 1969).

The dispersive technique developed previously is used in order to determine the Regge parameters of the $B^\pm$ πN forward spin-flip amplitudes, and these are compared with the ones proposed by Rarita by fitting high energy data. Although the two determinations of the B^- parameters agree fairly well, not one of the solutions of the B^+ parameters proposed by Rarita agree. (J.F.P.)

15135 ISOVECTOR FORM FACTORS FROM ANNIHILATION AND π-π DYNAMICS. II. DEPENDENCE ON MOMENTUM TRANSFER. Bergia, S. (Univ., Modena, Italy. Istituto Nazionale di Fisica Nucleare, Bologna); Mignaco, I. A.; Oberholzer, J. Nuovo Cim., Lett., 1: 279-84(Feb. 11, 1969).

The contribution of the nucleon pole in πN elastic scattering to the isovector anomalous magnetic form factor was previously analyzed. It was shown that the nucleon contribution in the framework of two-pion unitarity is not enough to describe the momentum transfer dependence. A model is presented to represent the distant contributions which could come from the continuum contribution of πN elastic scattering to the annihilation amplitudes or from the 2n-pion channel contributions to unitarity on the right-hand cut. (J.F.P.)

15136 SUPERCONVERGENT SUM RULES FOR BACKWARD SCATTERING. Seth, V. P.; Agarwal, B. K. (Allahabad Univ., India). Nuovo Cim., Lett., 1: 285-8(Feb. 11, 1969).

It is found that the ambiguity present in the superconvergence model of Griffiths and Palmer can be removed by using a linear combination of two amplitudes. The predicted results are consistent with other calculations and lend support to the assumptions made that the asymptotic behavior of the elastic scattering amplitudes is given by the Reggeized u-channel trajectory of the nucleon, and the superconvergence relations can be well approximated by taking contributions from low-lying intermediate states in the s- and t-channels. (J.F.P.)

15137 CP-VIOLATION IN NONLEPTONIC HYPERON DECAYS IN CURRENT–CURRENT MODELS. Gronau, M. (Tel-Aviv Univ.). Nuovo Cim., Lett., 1: 209-13(Feb. 1, 1969).

Detailed consequences of two current–current theories are tested in possible effects in the nonleptonic decays of hyperons. An attempt is made to determine whether there is any process in which one might expect the effect to be more pronounced than in other hyperon decays. (J.F.P.)

15138 EMPIRICAL MASS FORMULAE, SCHWINGER'S QUANTUM NUMBERS AND NONLEPTONIC DECAYS. Guersey, F.; Serdaroglu, M. (Middle East Technical Univ., Ankara). Nuovo Cim., Lett., 1: 233-6(Feb. 1, 1969).

It is assumed that the operator H_8, introduced by Schwinger, transforms like an octet to be compatible with the Gell-Mann–Okubo mass formula. This operator can be shown to take the form of the symmetry-breaking part of the Gell-Mann–Okubo mass formula with a definite F/D ratio. Experimental masses give for this ratio 2.97, which is very close to the integer value of 3. It is shown that the latter value is relevant for Schwinger's quantum number. (J.F.P.)

15139 EVIDENCE OF THE HARD CORE IN MULTI-GeV K^+p ELASTIC SCATTERING. Libby, L. Marshall; King, N. S.; Rost, E. (Univ. of Colorado, Boulder). Phys. Lett., 28B: 465-67(Jan. 20, 1969).

It is shown that K^-p and K^+p elastic scattering from 2 to 20 GeV/c laboratory beam momentum can be fitted by a single imaginary Yukawa potential term together with a hard core as the potential function in the Dirac equation. A fit cannot be obtained this way unless a hard core is used. Thus three parameters have been found to reproduce elastic scattering over this entire range. (auth)

15140 ANALYSIS OF CHARGE EXCHANGE MESON–BARYON REACTIONS FROM REGGEIZED SUPERMULTIPLET THEORY. Delbourgo, R.; Salam, A. (Imperial Coll. of Science and Tech., London). Phys. Lett., 28B: 497-500(Jan. 20, 1969).

Parameter-free fits to charge exchange reactions $PB \to PB^*$ and $PB \to PB$ in the range p_{Lab} from about 4 to 13 GeV/c are presented, based on an exchange of an orbitally Reggeized supermultiplet $(\bar{6},6) \oplus (\bar{6},6)$. Notwithstanding the simplification of neglecting mass differences and assuming exchange degeneracy (with a common trajectory $\alpha(t) = 0.5 + t$), the agreement of theory with experiment is rather good, considering that beyond an overall constant there is no adjustable parameter. (auth)

15141 INTERFERENCE EFFECT IN PERIPHERAL PRODUCTION OF ρ-MESONS. Grecchi, V. (Univ., Florence. Univ., Bologna); Selleri, F.; Turchetti, G. Nuovo Cim., 59A: 328-34 (Feb. 1, 1969).

It is shown that the observed anisotropies in the Treiman–Yang angle for the reaction $\pi N \to 2\pi N$ can be accounted for as interference effects between a one-pion-exchange amplitude with form factors and a slowly varying background amplitude: at the same time the dependence of the spin-density matrix elements on the $\pi\pi$ mass is explained. (auth)

15142 CONJECTURE ON THE ROPER RESONANCE. Dilley, J. (Ohio Univ., Athens). pp 173-86 of High Energy Physics and Fundamental Particles. Barut, Asim O.; Brittin, Wesley E. (eds.). New York, Gordon and Breach, Science Publishers, 1968.

The basis features of the Roper resonance are discussed. The possibility that this resonance corresponds to one of the cases where the phase shifts rise through $\pi/2$ and where there is no associated pole is considered by means of Regge trajectories. An argument is given that allows the Roper resonance to be produced by an interference mechanism. (L.B.S.)

15143 CONDITIONS ON THE SPIN-DENSITY MATRICES DUE TO INTERNAL SYMMETRY. Kamei, O.; Sasaki, S. (CNRS, Paris. Institut des Hautes Etudes Scientifiques, Bures-sur-Yvette, France). Nuovo Cim., 59A: 535-44(Feb. 21, 1969).

The restrictions on the spin-density matrices due to internal symmetry are given for the two-body reactions with particles of arbitrary spin. The polarization data for high-energy πN reactions are examined to find that the observed values seem to be maximum possible values compatible with the charge independence. (auth)

Strong (Baryon No. ≥ 2)

Refer also to abstracts 14475, 14575, 14977, 15036, 15091, 15095, and 15115.

15144 (ITF-68-25) CONNECTION BETWEEN FORMFACTOR AND PHYSICAL S-MATRIX. Troitskii, V. E.; Shirokov, Yu. M. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1968. 11p. (In Russian). (CONF-680453-12). Dep.

From 2nd Conference on Axiomatical Field Theory and Theory of Elementary Particles, Kiev, USSR.

A method developed previously is employed to construct the connection between the two-particle matrix element of vector current and deuteron form factor on the one hand and the physical S-matrix on the other hand. (auth)

15145 (ITF-68-80) ENERGY LEVELS OF TWO AND THREE NUCLEON PROBLEMS WITH YUKAWA POTENTIAL IN THE STRONG CONNECTION APPROXIMATION. Simenog, I. V. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1968. 10p. (In Russian). Dep.

Explicit dependence of energy levels of two nucleons interacting through Yukawa-type potential (singular at zero) on the coupling constant g is obtained in the framework of strong coupling approximation method. Generalization of the method also unifying previous results is presented for the case of arbitrary potential. Binding energy for three nucleons with Yukawa and Hulthen potentials is evaluated, the results being in good correspondence with numerical calculations carried out by means of the factorization method. (auth)

15146 ANALYSIS OF $pp \to pp\pi^+\pi^-$ AT 16 GeV/c BY THE MULTI-REGGE-POLE EXCHANGE MODEL. Rushbrooke, J. G.; Williams, J. R. (Cavendish Lab., Cambridge, Eng.). Phys. Rev. Lett., 22: 248-51(Feb. 10, 1969).

Experimental distributions for the reaction $pp \to pp\pi^+\pi^-$ at 16 GeV/c are consistent with predictions of a Regge-pole model incorporating exchange of a Reggeized pion. The Treiman–Yang angle distribution affords a distinctive test in favor of pion Reggeization for this reaction. (auth)

15147 POLARIZATION EFFECTS AT THE ELASTIC Nd SCATTERING IN THE GLAUBER APPROXIMATION. Tseren, Ch. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 8: 1227-31(Dec. 1968). (In Russian).

Spin dependence of the total Nd-interaction cross section is considered in the Glauber approximation. Using the data on the NN-scattering a numerical estimate is presented for the effect of the contribution from the double collisions to the total cross section of the nucleon interaction with aligned deuterons. (auth)

15148 NUCLEON–NUCLEON MODELS, CHARGE SPLITTING, AND THE NUCLEON–NUCLEON DATA NEAR 210 MeV. Miller, M. D. (Michigan State Univ., East Lansing); Signell, P. S.; Yoder, N. R. Phys. Rev., 176: 1724-9(Dec. 25, 1968).

Phase-shift analyses were made of the nucleon-nucleon scattering data near 210 MeV. Several nuclear potential models are compared with the results and are found to be clearly distinguishable by differences in their isospin-singlet phase shifts, particularly by the coupling parameter ϵ_1 which is of importance for nuclear physics. There is no evidence of charge splitting in the $^1S_0$ state. (auth)

15149 TWO-PION-EXCHANGE CONTRIBUTIONS TO NUCLEON–NUCLEON SCATTERING. Wortman, W. R. (Texas A and M Univ., College Station). Phys. Rev., 176: 1762-8 (Dec. 25, 1968).

Contributions to N-N phase shifts are found, using Feynman diagrams through fourth order in the coupling constant in pseudoscalar-meson theory. The amplitudes are evaluated using Cutkosky's method to express them in dispersion-relation form, and geometric unitarization is applied to calculate phase shifts. In addition to pion and nucleon intermediate states, particles in the baryon and pseudoscalar octets are allowed, subject to SU_3 symmetry. The results indicate that there are features of the phase shifts, particularly in higher partial waves, that are due to two-pion-exchange effects. The addition of the SU_3-restricted intermediate states gives no improvement. (auth)

15150 TWO-BOSON-EXCHANGE EFFECTS IN NUCLEON–NUCLEON SCATTERING. Haracz, Richard D. (Drexel Inst. of Tech., Philadelphia); Sharma, Ravi D. Phys. Rev., 176: 2013-18(Dec. 25, 1968).

The two-pion-exchange contribution to nucleon-nucleon scattering is studied at scattering energies of 95 and 310 MeV through a partial-wave analysis of the exact relativistic scattering matrix. Additional two-boson-exchange effects are also studied at these energies corresponding to the $\pi + \eta$ and $\pi + \sigma$ exchange processes, with η the pseudoscalar resonance and σ the scalar resonance. It is found that the two-pion-exchange (TPE) phase parameters are large compared with one-pion-exchange (OPE) phase parameters for low values of L, and OPE + TPE is a reasonable representation of the phenomenological phases for the lower energy when $L \geq 3$ and for the higher energy when $L \geq 5$. The $\pi + \eta$ effect is found to be small compared with the pion-theoretical effects, but the $\pi + \sigma$ effect is large for a light scalar resonance if it couples strongly with the nucleon. (auth)

15151 THREE-BODY INTERACTION EFFECTS IN HIGH-ENERGY SCATTERING FROM DEUTERONS. Harrington, David R. (Rutgers-The State Univ., New Brunswick, N. J.). Phys. Rev., 176: 1982-5(Dec. 25, 1968).

Corrections to the Glauber multiple-scattering expansion due to three-body interactions are studied. The particular interaction considered corresponds to the scattering of an incident particle from a pion being exchanged by the two nucleons composing a deuteron. It is shown that the resulting correction to the scattering amplitude must be modified to take into account the possibility of absorption on the nucleons. A crude numerical estimate indicates corrections of about -0.4% to the total cross section at very high energy. The effect on the differential cross section at large momentum transfer is difficult to estimate reliably, but the formulas obtained suggest that the corrections could become quite important unless there is a strong off-shell damping mechanism. (auth)

15152 HIGH-ENERGY SCATTERING BY NUCLEI. Remler, Edward A. (Coll. of William and Mary, Williamsburg, Va.). Phys. Rev., 176: 2108-12(Dec. 25, 1968).

The relationship between the Glauber approximation and Watson's multiple-scattering equation is discussed. On this basis a correction term to the Glauber approximation is proposed. (auth)

15153 FIELD-THEORETICAL NUCLEON–NUCLEON POTENTIAL. Partovi, M. H.; Lomon, E. L. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev. Lett., 22: 438-41(Mar. 3, 1969).

An unambiguous formulation is presented for the derivation of the two-pion as well as one-boson exchange contributions to the nucleon-nucleon potential. It contains no internal momentum expansions, and depends only on experimentally determined coupling and mass parameters. The calculated result, containing terms linear in the momentum operator, is remarkably close to the Hamada–Johnston potential for distances $r \gtrsim 0.7$ F. (auth)

15154 EFFECT OF QUADRUPOLE DEFORMATION ON HIGH-ENERGY SCATTERING BY DEUTERONS. Franco, Victor (Los Alamos Scientific Lab., N. Mex.); Glauber, Roy J. Phys. Rev. Lett., 22: 370-4(Feb. 24, 1969).

The high-energy elastic scattering cross sections of the deuteron are shown, because of the d-state admixture, to be strongly dependent on the polarization of the deuteron spin. The polarization dependence is shown to explain the absence of a pronounced minimum in the differential cross section for unpolarized deuterons. For polarized deuteron targets, on the other hand, the minimum should assume a clearly observable form. (auth)

15155 Λ-NUCLEON TENSOR INTERACTIONS IN $^3H_\Lambda$. Buxton, L. D.; Schrils, R. (Univ. of Kentucky, Lexington). Nuovo Cim., 59B: 21-27(Feb. 11, 1969).

The effect of a Λ-nucleon tensor potential on the binding energy of $^3_\Lambda$H and on the effective-range parameters of Λ-proton scattering is investigated. It is found that such a potential contributes negligibly to the binding energy of $^3_\Lambda$H; but, it has a large effect on the scattering parameters. The latter result enables one to find potentials which are in good agreement with the binding energy of $^3_\Lambda$H and the effective-range parameters, without the introduction of hard cores. (auth)

15156 REGGE DIPOLE AND HIGH ENERGY BEHAVIOR AT LARGE |t|. Sawada, Tetsuo (Tokyo Univ. of Education). pp 267-81 of High Energy Physics and Fundamental Particles. Barut, Asim O.; Brittin, Wesley E. (eds.). New York, Gordon and Breach, Science Publishers, 1968.

The high-energy behavior of the scattering amplitudes at relatively large momentum transfer is interpreted in the framework of Regge theory. The Regge dipole is first explained and the experimental situation of high-energy proton-proton scattering is reviewed. Functional equations for $\alpha(t)$ and $\beta(t)$ are derived from the unitarity condition, and are changed into difference equations of the first order. By solving these equations, the differential cross section is determined up to two arbitrary periodic functions. (L.B.S.)

Particle Invariance Principles and Symmetries

General

Refer also to abstracts 14647 and 15263.

15157 SIMULTANEOUS PARTIAL-WAVE EXPANSION IN THE MANDELSTAM VARIABLES: THE GROUP SU(3). Balachandran, A. P. (International Centre for Theoretical Physics, Trieste, Italy. Syracuse Univ., N. Y.); Meggs, W. J.; Nuyts, J.; Ramond, P. Phys. Rev., 176: 1700-4(Dec. 25, 1968).

The elastic scattering amplitude of two spinless particles of equal mass ½ was xpanded elsewhere in a double series of eigenfunctions which "displayed" its dependence on all the Mandelstam variables s, t, u (s + t + u = 1). The expansion was then used to investigate the crossing properties of partial-wave amplitudes. It is shown that these eigenfunctions are certain basis vectors of the representations (σ,σ) of a suitably defined SU(3). The unequal-mass problem is also discussed. (auth)

15158 ANGULAR ANALYSIS OF ELEMENTARY PARTICLE REACTIONS. Moussa, P.; Stora, R. (CEN de Saclay, Gif-sur-Yvette, France). pp 265-340 of Methods in Subnuclear Physics. Vol. 2. Nikolic, M. (ed.). New York, Gordon and Breach, Science Publishers, Inc., 1968.

The consequences of relativistic invariance are primarily discussed, following a line of reasoning due to Wigner, which lead to all known results concerning the phenomenological angular analysis of particle collisions. The formulation of symmetry laws in quantum mechanics and the basic theorem of Wigner are treated, and the implications of these for collision amplitudes are discussed. Particles of arbitrary masses and spins are described, following Wigner's analysis. Assemblies of identical particles subject to Fermi or Bose statistics are then described in terms of the corresponding fields. Two-particle states are analyzed in terms of the so-called l-s, multipole, and helicity couplings, and the corresponding analysis of a reaction involving two incoming and two outgoing particles is given. Three-particle states are examined for which relativistic effects are slightly more subtle than for two particle states. l-s or helicity couplings in cascade are compared to a symmetric coupling. Reduction formulas pertaining to a field theory of the LSZ type are given in one of the technical appendices. (L.B.S.)

15159 GENERALIZATIONS OF SU(6). Ruegg, H. (Univ., Geneva). pp 733-67 of Methods in Subnuclear Physics. Vol. 2. Nikolic, M. (ed.). New York, Gordon and Breach, Science Publishers, Inc., 1968.

Group theoretical generalizations of SU(6) are examined. Certain aspects of the rotation group and Lorentz group are first reviewed. The $SU(2)_w$ group is then discussed as an example of an index invariance group. The $SU(6)_w$ collinear group, the S(U(3) × U(3)) collinear and coplanar groups, and the hierarchy of groups are discussed. Representations of SU(6) for classification of particles are examined. Applications to electromagnetic form factors, vector meson decays, and cross section relations are given. (L.B.S.)

15160 AN INTRODUCTION TO SU_3. Stannard, F. R. (University Coll., London). pp 697-732 of Methods in Subnuclear Physics. Vol. 2. Nikolic, M. (ed.). New York, Gordon and Breach, Science Publishers, Inc., 1968.

The first part deals with the idea of groups in general. The usefulness of symmetries, groups, representations, and sub-groups is discussed. Part 2 deals with isotopic spin, SU_2, and basic doublets; SU_3 and sakatons; the eight-fold way, U-spin; SU_3 predictions; and quarks. (L.B.S.)

15161 REGULAR REPRESENTATION OF THE GROUP SU_3: EIGENFUNCTIONS AND EIGENVALUES OF THE BELTRAMI–LAPLACE OPERATOR DEFINED ON THE 4-DIMENSIONAL MANIFOLD IN THE EUCLIDEAN SPACE R_8. Liotta, R. S. (Univ., Rome. Istituto Nazionale di Fisica Nucleare, Rome); Triolo, L. Nuovo Cim., 59A: 303-7(Jan. 21, 1969).

It is known that the space of the fundamental representation of SU_3 has six real dimensions. Consequently there are one radial and four angular spherical generalized co-ordinates. The latter have been used to express, in differential form, the operators I^2, I_3, Y and the spherical harmonics (eigenfunctions of the invariant Beltrami–Laplace operator). In this work the space of the regular representation is parametrized by five real spherical variables, the first one radial, the other angular. By the latter the spherical harmonics eigenfunctions of the Beltrami–Laplace operator, the eigenvalues, and the operators I^2, I_3 and Y are expressed. (auth)

15162 ON THE REALIZATION OF SEMI-SIMPLE LIE ALGEBRAS WITH QUANTUM CANONICAL VARIABLES. Simoni, A.; Zaccaria, F. (Syracuse Univ., N. Y.). Nuovo Cim., 59A: 280-92(Jan. 21, 1969).

An analysis is done about the realization of semi-simple Lie algebras in the field of quotients of the Heisenberg algebra. An explicit solution is given for A_l and C_l. (auth)

15163 GOLDSTONE THEOREM AND POSSIBLE APPLICATIONS TO ELEMENTARY PARTICLE PHYSICS. Duerr, H. P. (Max-Planck Inst., Munster, Ger.). Proc. Conf. Phys., 14th, Univ. Brussels, 1967, 1-21(1968).

From 14th Conference on Physics, Brussels, Belgium. See CONF-671076.

The Goldstone theorem states that, under certain conditions, in a dynamical theory which is invariant under a particular symmetry group and where this symmetry group is broken by the ground-state, e.g., the vacuum state in a relativistic field theory, there must exist particles of zero mass or, in the nonrelativistic case, excitation modes, the energy of which tends to zero with increasing wavelength. Reasons why this theorem is of great interest to elementary particle physics are discussed. It is concluded that, to present knowledge, no case exists in which a dynamically valid symmetry in a relativistic causal theory can be broken by the ground state in an observable way without involving zero mass particles. The main problem in connection with the Goldstone theorem in relativistic theories appears to be connected with physical interpretation of the accompanying assumptions — in particular what is meant by a symmetry and its violation — and the physical interpretation of the derived consequences — in par-

ticular whether an approximate symmetry is derived for the non-degenerate one-particle states belonging originally to a single multiplet of the symmetry group— and what are the symmetry properties of the zerons. These problems may probably be solved by carrying out dynamical calculations. (UK)

15164 UNITARY REPRESENTATIONS OF SL(2,C) IN AN E(2) BASIS. Chang, Shau-jin; O'Raifeartaigh, L. (Inst. for Advanced Study, Princeton, N. J.). J. Math. Phys. (N.Y.), 10: 21-9(Jan. 1969).

Starting from the functional representation of Gel'fand and Naimark, the unitary irreducible representations of SL(2,C) are described in a basis of the subgroup E(2) ⊗ D, where E(2) ⊗ D is the subgroup of all 2 × 2 matrices of the form $\begin{pmatrix} e^{i\theta} & \gamma \\ 0 & e^{-i\theta} \end{pmatrix}$, $\alpha\delta = 1$. Physically, this is the subgroup into which SL(2,C) degenerates at infinite momentum and may be thought of as the 2-dimensional Euclidean group together with its dilations. Advantages to using the E(2) ⊗ D basis are: It is convenient to calculate form factors; the generators of E(2) ⊗ D are represented either multiplicatively or by first-order differential operators and are independent of the values of the SL(2,C) Casimir operators; the principal and supplementary series of SL(2,C) are treated on the same footing and, in particular, have the same inner product; and the transformation coefficients to the usual angular-momentum basis are related to Bessel functions. The E(2) ⊗ D is used to compute explicitly the finite matrix elements of an arbitrary Lorentz transformation and to investigate the structure of vector operators in unitary representation of SL(2,C). (auth)

15165 PROOF OF THE FERMION SUPERSELECTION RULE WITHOUT THE ASSUMPTION OF TIME-REVERSAL INVARIANCE. Hegerfeldt, G. C. (Institut fuer Theoretische Physik, Marburg, Ger.).; Kraus, K.; Wigner, E. P. J. Math. Phys. (N. Y.), 9: 2029-31(Dec. 1968).

The superselection rule which separates states with integer angular momentum from those with half-integer angular momentum is proved using only rotational invariance. (auth)

15166 ON THE CLEBSCH-GORDAN SERIES OF A SEMISIMPLE LIE ALGEBRA. Radhakrishnan, D. (Univ. of Delhi). J. Math. Phys. (N. Y.), 9: 2061-3(Dec. 1968).

The problem of determining the multiplicity of an irreducible representation of a semisimple Lie algebra, in the decomposition of the product of two such representations, is reduced to one of solving a system of linear equations. This is achieved by using some properties of partition functions which occur in the formulas for the multiplicity of a weight in a representation. It is shown that one need not know the partition function explicitly. (auth)

15167 REDUCTION OF REDUCIBLE REPRESENTATIONS OF THE POINCARE GROUP TO STANDARD HELICITY REPRESENTATIONS. Moses, Harry E. (Massachusetts Inst. of Tech., Lexington). J. Math. Phys. (N. Y.), 9: 2039-49(Dec. 1968).

Realizations are introduced of the generators of the Poincaré group for real and imaginary masses which are close in form to the Lomont–Moses realizations for zero mass. These realizations (which are called "standard helicity realizations or representations") are characterized by the way that the infinitesimal generators are given in terms of the helicity operator. Also the global form of the realizations is given, and the realizations for the case that they are unitary and irreducible are discussed in detail. It is then shown how any reducible representation of the Poincaré group for which the infinitesimal generators of the translation and rotation subgroups are Hermitian and integrable and for which the space–time generators are integrable (but not necessarily Hermitian) can be reduced to the standard helicity realizations. In the case that the reducible representation is unitary, this process enables one to reduce the reducible representation to irreducible unitary standard helicity representations. Finally, it is shown how the Foldy–Shirokov realizations for real mass are related to the standard helicity representation. (auth)

15168 A POSSIBLE EXTENSION OF THE CONCEPT OF PAULI SPIN TO THE SO(p,1) AND In(SO(p,1)) GROUPS. Gueret, Philippe; Vigier, Jean-Pierre (Institut Henri Poincare, Paris). Compt. Rend., Ser. A and B, 267: 997-9(Nov. 4, 1968). (In French).

It is possible to extend to the case of the SO(p,1) and In(SO(p,1)) groups the classic ideas on spin, introduced by Pauli. If the cases of the SO(2n + 1,1) and SO(2n,1), for positive integral n are distinguished, it is seen that in the first case the spin is generalized by a pseudo-tensor for SO(2n + 1,1) and a pseudo-vector for IN(SO(2n + 1,1); in the second case one obtains a pseudo-vector for SO(2n,1) and a pseudo-tensor for In(SO(2n,1)). The generalization of the relations given by Pauli for SO(3,1) and In(SO(3,1)) was calculated explicitly. (tr-auth)

15169 CLASS OF REPRESENTATIONS OF THE IU(n) AND IO(n) ALGEBRAS AND RESPECTIVE DEFORMATIONS TO U(n,1), O(n,1). Chakrabarti, A. (Ecole Polytechnique, Paris). J. Math. Phys. (N. Y.), 9: 2087-2100(Dec. 1968)

The matrix elements of the generators of the algebra of U(n) × I_{2n} are defined directly on a chosen basis. This construction, though naturally infinite-dimensional, has a very close formal resemblance (interpretable, if so desired, in terms of a suitably defined "contraction" procedure) to the Gel'fand–Zetlin (GZ) representation for U(n + 1). The representations obtained are characterized by (n – 1) integers and one continuous parameter. Then the formal analog with the GZ pattern is exploited in order to prove the necessary commutation relations and to derive the explicit expressions for some invariants. However, direct alternative methods are indicated where they are useful. The representation is easily enlarged to that of (U(n) ⊗ U(1)) × I_{2n}, which are used together with a deformation formula to obtain a class of representations of the U(n,1) algebra. The irreducible components are characterized by (n–1) integers and two continuous parameters. The deformation formula is compared with that of Rosen and Roman. The typical difficulties that arise for the case IU(p,q) (q ≥ 1) are briefly indicated. Parallel constructions finally are given for the IO(n) and O(n,1) algebras. (auth)

15170 MASTER ANALYTIC REPRESENTATION: REDUCTION OF O(2,1) IN AN O(1,1) BASIS. Kuriyan, Jacob G. (Inst. for Advanced Study, Princeton, N. J.); Mukunda, N.; Sudarshan, E. C. G. J. Math. Phys. (N. Y.), 9: 2100-8(Dec. 1968).

The reduction of the pseudo-orthogonal group O(2,1) with respect to a noncompact O(1,1) basis is displayed. After the explicit solution is obtained, the results are rederived using the method of master analytic representations. (auth)

15171 THE CPT THEOREM AND ODD-DIMENSIONAL SPACE–TIME. Manoharan, A. C. (Univ. of Wisconsin, Milwaukee). Nuovo Cim., Lett., 1: 125-8(Jan. 11, 1969).

The CPT theorem is generalized for any odd-dimensional space-time using scalar fields. (W.H.K.)

15172 INDIVIDUAL U_3 SYMMETRIES OF STRONG, ELECTROMAGNETIC, AND WEAK INTERACTIONS. Itoh, C. (Meiji-Gakuin Univ., Tokyo). Nuovo Cim., Lett., 1: 103-6(Jan. 11, 1969).

The possibility of U_{3st}, $U_{3\gamma}$ and U_{3wk} symmetries (st, γ, and wk = strong, electromagnetic, and weak) under which H_{st}, H_γ, and H_{wk} are invariant, respectively, is investigated. (L.B.S.)

15173 DIAGONALIZATION PROBLEM AND SUPERSELECTION RULES. Teppati, G. (Univ., Palermo, Italy. Istituto Nazionale di Fisica Nucleare, Palermo, Italy). Nuovo Cim., Lett., 1: 65-9(Jan. 11, 1969).

An attempt is made to derive all the possible superselection rules which may be imposed between states of some irreducible projective co-representations of the extended Poincare group. (L.B.S.)

15174 COMBINATORIAL STRUCTURE OF STATE VECTORS IN U_n. I. HOOK PATTERNS FOR MAXIMAL AND SEMIMAXIMAL STATES IN U_n. Ciftan, Mikael; Biedenharn, L. C. (Duke Univ., Durham, N. C.). J. Math. Phys. (N.Y.), 10: 221-32(Jan. 1969).

It is shown that, in the boson-operator realization, the state vectors of the unitary groups U_n—in the canonical chain $U_n \supset U_{n-1} \supset \cdots \supset U_1$—can be obtained ab initio by a combinatorial probabilistic method. From the Weyl branching law, a general state vector in U_n is uniquely specified in the canonical chain; the algebraic determination of such a general state vector is in principle known (Cartan–Main theorem) from the state vector of highest weight; the explicit procedure is a generalization of the SU(2) lowering-operator technique. The present combinatorial method gives the normalization of these state vectors in terms of a new generalization of the combinatorial entity, the Nakayama hook, which generalization arises ab initio from a probabilistic argument in a natural way in the lowering procedure. It is the advantage of the general hook concept that it recasts those known algebraic results into a most economical algorithm which clarifies the structure of the boson-operator realization of the U_n representations. (auth)

15175 REPRESENTATION COEFFICIENTS FOR THE SU(3) GROUP. Chacon, E. (Univ. Nacional de Mexico, Mexico City). Rev. Mex. Fis., 17: 315-25(1968).

The general SU(3) matrix is factorized into the product of five matrices, of which three belong to the same SU(2) subgroup and the other two are the matrix of the transposition (2,3). Using the previously determined matrix elements of the transposition (2,3), the representation coefficients of SU(3) are obtained as linear combination of products of three representation coefficients of

SU(2). From this expression it is verified that the SU(3) Gelfand basis states are a particular case of the representation coefficients. (auth)

15176 POINCARE INVARIANCE AND MANIFESTLY COVARIANT EQUATIONS. Parravicini, G. (Univ., Milan); Sparzani, A.; Pauri, M. Nuovo Cim., Lett., 1: 295-301(Feb. 11, 1969).

The problem of reducing $\Psi_{lm}(p)$ in terms of $\Phi_{m_s}(p)$ arises owing to the reducible character of the Poincaré group. It is clear that this reduction is actually a dynamical analysis of both the wave equation and the supplementary conditions. A brief account is given of this analysis in the most general case. In this connection the specific nature of the transformation which performs the reduction is discussed as a generalized Foldy–Wouthuysen transformation. (J.F.P.)

15177 RELATIONSHIP BETWEEN INTERNAL AND SPACE-TIME SYMMETRIES. Fleischman, Owen (Boston Univ.). pp 691-708 of High Energy Physics and Fundamental Particles. Barut, Asim O.; Brittin, Wesley E. (eds.). New York, Gordon and Breach, Science Publishers, 1968.

Some phenomenological relations that have been fairly well established between the internal symmetries of hadrons and space-time symmetries are examined in a theory independent manner. Massive particles are required to have a mathematically precise nonrelativistic limit. The relativistic particle is described via an irreducible representation of the Poincaré group and the nonrelativistic particle is described via a finite mass irreducible representation of the inhomogeneous Galilei group. (L.B.S.)

15178 ALGEBRAIC METHOD AND INFINITE COMPONENT WAVE EQUATIONS. Boehm, A. (Syracuse Univ., N. Y.). pp 483-526 of High Energy Physics and Fundamental Particles. Barut, Asim O.; Brittin, Wesley E. (eds.). New York, Gordon and Breach, Science Publishers, 1968.

The infinite component wave equation approach is presented in a way which exhibits its relation to the algebraic method. The Majorana case is described in full detail and an algebraic reformulation of it is given. The Nambu and Fronsdal equations are considered. (auth)

15179 TENSORIAL CURRENT OPERATORS AS REPRESENTATIONS OF THE EXTENDED POINCARE GROUP. Guersey, Feza (Yale Univ., New Haven. Middle East Technical Univ., Ankara). pp 303-23 of High Energy Physics and Fundamental Particles. Barut, Asim O.; Brittin, Wesley E. (eds.). New York, Gordon and Breach, Science Publishers, 1968.

A classification of local covariant current operators and their properties within the Poincare group including P, T, and C is studied. The point of view is adopted that these local tensorial currents are the chief observables of field theory. Experimental information can be obtained by taking their matrix elements between the various particle states. The properties of the currents lead to various selection rules and relations for these matrix elements. (L.B.S.)

15180 LORENTZ-COVARIANT BILINEAR FUNCTIONALS. Wess, J. (New York Univ., N. Y.). pp 325-38 of High Energy Physics and Fundamental Particles. Barut, Asim O.; Brittin, Wesley E. (eds.). New York, Gordon and Breach, Science Publishers, 1968.

A short introduction is given to the theory of representations of the homogeneous orthochronous Lorentz group. Topics discussed include representations of SL(2C), covariant bilinear functionals, invariant functionals and classification of representations, tensor functionals and group generators, and vector functionals and currents. (L.B.S.)

Applications (Electromagnetic and Weak)

Refer also to abstracts 15093 and 15518.

15181 (COO-264-473) PCAC AND THE DALITZ PAIR PROCESS. Chang, T. H. (Chicago Univ., Ill. Enrico Fermi Inst. for Nuclear Studies. Chicago Univ., Ill. Dept. of Physics). Jan. 1969. Contract AT(11-1)-264. 8p. (EFI-69-4). Dep. CFSTI.

PCAC is introduced into $\pi^0 \rightarrow \gamma + e^+ + e^-$, the Dalitz pair process, and the distribution function used to describe the electron-positron pair correlations is compared with the theoretical calculations of Kroll and Wada and Joseph which were based on quantum electrodynamics only. From the experimental work of Samios, it shows the experiment favors quantum electrodynamical calculation. (auth)

15182 RELATION OF CHARGED-K DECAY TO CP VIOLATION. Delaney, Robert M. (St. Louis Univ.); Welling, Daniel J. Phys. Rev., 176: 1841-5(Dec. 25, 1968).

An SU(3) model is described which relates the rate of the charged-K decay $K^+ \rightarrow \pi^+ + \pi^0$ to the magnitude of CP violation. A weak-interaction Lagrangian for nonleptonic processes is constructed from octet currents in a Cabibbo frame under the hypothesis that the CP-conserving processes are described predominantly by an octet-dominant interaction Lagrangian, and that the CP-violating processes enter solely through the 27-dimensional representation of 8⊗8. Three types of octet currents are used: L_μ, which is linear in the field operators, and J_μ and K_μ, which are bilinear and possess opposite C-transformation properties. It is shown that if only I = 2 contributions enter into the 27 portion of the Lagrangian, then, approximately $|K_S\rangle$ and $|K_L\rangle$ by the CP eigenstates $|K_1\rangle$ and $|K_2\rangle$, the observed rate of the charged-K decay and $\theta = 0.26$ for the Cabibbo angle fix $|\eta_{+-}| = 5.38 \times 10^{-3}$ and $|\eta_{00}| = 3.12 \times 10^{-3}$, of the proper order of magnitude. Introducing the experimentally observed departure of $|K_S\rangle$ and $|K_L\rangle$ from CP eigenstates and a renormalization constant for the K current yields $|\eta_{+-}| = 1.97 \times 10^{-3}$ and $|\eta_{00}| = 2.92 \times 10^{-3}$, in good agreement with experiment. (auth)

15183 $K \rightarrow 2\pi$ PHENOMENOLOGY WITH SMALL CP NONCONSERVATION. Roper, L. David (Virginia Polytechnic Inst., Blacksburg). Phys. Rev., 176: 2120-4(Dec. 25, 1968).

The theoretical expressions for experimentally determined parameters for $K \rightarrow 2\pi$ decays are used to determine solutions for various theoretical parameters. This is accomplished by first assuming CP conservation and then treating the CP-nonconserving parts of the theoretical expressions as small corrections. Two types of solutions are found: one type for which $|\Delta I| = \frac{1}{2}$ dominance is valid, and one type for which $|\Delta I| = \frac{1}{2}$ dominance is not valid. There are two solutions of each type, but only one solution ($|\Delta I| = \frac{1}{2}$ type) yields the original data when substituted in the exact equations. All four solutions are used as input in a least-squares fit to the data, and are thereby transformed into exact solutions. No other exact solutions were found in a large number of random-input searches. Two of the four solutions agree with values of $\mathrm{Re}\epsilon$ determined in leptonic decays; however, they give different predictions for the phase of η_{00}. (auth)

15184 SOME MASS-SPLITTING THEOREMS. O'Raifeartaigh, L. (Syracuse Univ., N. Y.). pp 527-38 of High Energy Physics and Fundamental Particles. Barut, Asim O.; Brittin, Wesley E. (eds.). New York, Gordon and Breach, Science Publishers, 1968.

The first lecture gives some background on mass splitting theorems. Various attempts to construct group-theoretical schemes from generalizations of the Dirac equation are outlined. In particular, the scheme based on embedding the inhomogeneous Lorentz group into a larger group G is considered. In the second lecture it is shown that this scheme cannot lead to physically interesting results. The question of obtaining the masses of elementary particles from G is considered. (L.B.S.)

Applications (Strong)

Refer also to abstract 14961.

15185 (ITF-68-37) LOW-ENERGY RELATIONS IN MESON-MESON SCATTERING. Pisarenko, V. G. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1968. 28p. (In Russian). Dep.

For the scattering of pseudoscalar mesons on vector mesons a number of relations between the coupling constants are derived from the superconvergence sum rules with account for the lowest resonance states. The conditions are studied under which the relations of de Alfaro et al., are obtained. The saturation of superconvergence sum rules in the SU(3)-symmetry scattering by the meson 35-plet leads to the results predicted by the collinear $SU(6)_W$-symmetry. (auth)

15186 (ITF-68-56) NONLINEAR REPRESENTATIONS OF THE LIE GROUPS. Khristov, Kh.; Stoyanov, D. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1968. 20p. Dep.

A brief review of the general theory of the realization of a given Lie group by its structure constants is given. The classification of nonlinear relativization of the SU(2) group is considered. It is shown that SU(2) possesses a finite number of irreducible representations and all the representations of dimensionality more than there are reducible. (auth)

15187 DECAYS OF ODD-PARITY BARYON RESONANCES. Carter, J. C. (Loyola Univ., New Orleans); Head, M. E. M. Phys. Rev., 176: 1808-11(Dec. 25, 1968).

Baryon members of the three-quark SU(6) 70 and 56 are coupled with a vector spurion assigned to the 1^3 of an SU(6) 35 to form odd-parity baryon resonances. Branching ratios for decays are calculated using the relativistic techniques of $SU(6)_w$ and are compared

with experiment. The $N^*_{\frac{1}{2}}$ (1518) and Y^*_1 (1660) are assigned to an $8^4 \subset 1^3 \otimes 8^2$ of $35 \otimes 70$. Observed branching ratios indicate that the decays proceed through the 70 channel as Capps has predicted. The Y^*_1 (1765), Y^*_0 (1830), and $\Xi^*_{\frac{1}{2}}$ (1935) are assigned to an $8^6 \subset 1^3 \otimes 8^4$ of $35 \otimes 70$. Missing members of these multiplets are discussed and branching ratios given. Decay amplitudes for other possible multiplets are stated. (auth)

15188 Σ^-d INTERACTION AND EXACT SU(3) SYMMETRY. Cortois, Jean; Deboudt, Marcel (Faculte des Sciences, Lille). Compt. Rend., Ser. A and B, 267: 993-6(Nov. 4, 1968). (In French).

SU(3) symmetry is used to find a relation between the initial state (Σ^-d) and the final states (Σ^0 + 2n) and (Λ + 2n) in order to obtain the branching ratio r of the two reactions Σ^-d $\rightarrow \Sigma^0$ + 2n and Σ^-d $\rightarrow \Lambda$ + 2n. A value for r was found in passable agreement with experiment. (tr-auth)

15189 HARMONIC-OSCILLATOR STATES FOR THREE-PARTICLE SYSTEMS. APPLICATION TO THE FORM FACTOR OF THE PROTON AS A SYSTEM OF THREE QUARKS. Aguilera Navarro, V. C. (Univ. Nacional de Mexico, Mexico City); Moshinsky, M.; Yeh, W. W. Rev. Mex. Fis., 17: 241-62(1968).

Three-particle harmonic-oscillator states are explicitly constructed with the following properties: a) That they are translationally invariant, b) That they have definite total orbital angular momentum, c) That they correspond to definite irreducible representations of the symmetric group of three particles S(3). (auth)

15190 GROUP-THEORETIC APPROACH TO CHIRAL TRANSFORMATIONS. Isham, C. J. (Imperial Coll. of Science and Tech., London). Nuovo Cim., 59A: 356-76(Feb. 1, 1969).

Nonlinear transformations of meson fields under any chiral group are derived in which the fields appear as a local co-ordinate system on a differentiable manifold. The techniques are extended to include any multiplet of nucleon fields. (auth)

15191 APPLICATION OF THE DYNAMICAL GROUP THEORY TO THE STRUCTURE OF THE HADRONS. Barut, A. O. (Univ. of Colorado, Boulder). pp 377-426 of High Energy Physics and Fundamental Particles. Barut, Asim O.; Brittin, Wesley E. (eds.). New York, Gordon and Breach, Science Publishers, 1968.

A comparison is first made of theories based on elementary or composite hadrons. The results of the application of the dynamic group theory is reviewed. The general assumptions of the theory are enumerated and are illustrated by examples of the hydrogen atom and Dirac particle. The O(4,2) theory of hadron structure is then treated. A simple approximation to the two-body scattering amplitudes in the dynamical group framework is presented. (L.B.S.)

15192 SU(3) IN MESON DECAYS. Goldberg, Marvin (Syracuse Univ., N. Y.). pp 35-50 of High Energy Physics and Fundamental Particles. Barut, Asim O.; Brittin, Wesley E. (eds.). New York, Gordon and Breach, Science Publishers, 1968.

A review is given of the present experimental situation concerning SU(3) classifications and decay rate predictions relating to mesons. (L.B.S.)

Field Theories

General

Refer also to abstract 14929.

15193 (ITF-68-39) SPECTRAL REPRESENTATIONS IN RENORMALIZED VECTOR THEORIES. Medvedev, B. V.; Pavlov, V. P.; Sukhanov, A. D. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1968. 28p. (In Russian). Dep.

The method developed earlier for the scalar theory is applied to a successive derivation of spectral representations in renormalized vector theories. The account for the stability and unitarity conditions enables one to formulate a nontrivial solvable model whose complete sets of states involves only single-particle ones. One of the solutions of this model corresponds to the correct introducing of field renormalization in the dispersion approach. A more general solution presents an example of the unitary and causal field theory with a nonlocal Lagrangian. As a result, the complete spectral representations for vector currents and fields are obtained as well as the vacuum expectation value for the equal-time commutator of currents, and an interpretation of the appearing spectral integrals is given. The correct separation of the vector field into longitudinal and transversal parts is carried out and the canonical commutators for the Heisenberg field is obtained. In conclusion, the case $m^2 = 0$ is considered wherever it is possible, which results in obtaining the spectral representations and other expressions applicable to the electromagnetic field. (auth)

Quantum Field Theory

Refer also to abstracts 14953, 14955, 14996, and 15153.

15194 (COO-264-464) QUANTIZATION OF FIRST OR SECOND ORDER PARTIAL DIFFERENTIAL RELATIVISTIC WAVE EQUATIONS. Lam, Yuk-Ming P. (Chicago Univ., Ill. Enrico Fermi Inst. for Nuclear Studies. Chicago Univ., Ill. Dept. of Physics). Dec. 1968. Contract AT(11-1)-264. 27p. (EFI-68-91). Dep. CFSTI.

The time-like solutions of a first or second order partial differential relativistic wave equation are used to construct a many-particle Hilbert space. Field operators are constructed on this space such that they form a representation of the complete Poincaré group (including space- and time-inversions), and satisfy the original wave equation. They therefore constitute a quantized theory. Requiring the Hamiltonian operator to be positive definitely leads to a definite statistics assignment and places severe limitations on the construction of wave equations. The CPT theorem is also discussed. (auth)

15195 (IFVE-STF-68-34-K) AN INVARIANT EXPANSION OF SOLUTIONS OF RELATIVISTIC EQUATIONS. Agamaliev, A. K.; Atakishiev, N. M.; Verdiev, I. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). 1968. 17p. (In Russian). Dep.

Relativistic equations for the nonzero mass vector field are considered. The relativistic invariant expansion of solutions inside and outside of light cone is obtained. It is shown that the nonrelativistic limit of a complete set of functions defined on the hyperboloid is the complete set corresponding to the flat three-dimensional space. (auth)

15196 (ITF-68-22) QUASILOCALITY OF A CLASS OF NONRENORMALIZABLE INTERACTIONS. Khoruzhii, S. S. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1968. 8p. (CONF-680453-5). Dep.

From 2nd Conference on Axiomatical Field Theory and Theory of Elementary Particles, Kiev, USSR.

A certain model of axiomatic field theory is considered, which assumes an arbitrarily high exponential growth order of vacuum expectation values in the momentum space. It is proved that this model still possesses the property of quasilocality (in Haag's sense) and the corpuscular interpretation. (auth)

15197 (ITF-68-23) SOME FEATURES OF SCALAR ELECTRODYNAMICS IN DISPERSION APPROACH. Pavlov, V. P.; Svechnikov, S. V.; Sukhanov, A. D.; Usyukina, N. I. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1968. 14p. (In Russian). (CONF-680453-9). Dep.

From 2nd Conference on Axiomatical Field Theory and Theory of Elementary Particles, Kiev, USSR.

The dynamical scheme of dispersion approach is applied to scalar electrodynamics. The effects of the renormalization of wave functions are accounted for. Higher current-like operators are found, and equal-time commutators of Heisenberg currents and fields are constructed. (auth)

15198 (ITF-68-24) THEORY OF NEUTRAL MASSIVE VECTOR FIELD IN DISPERSION APPROACH. Pavlov, V. P.; Svechnikov, S. V.; Sukhanov, A. D. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1968. 14p. (In Russian). (CONF-680453-10). Dep.

From 2nd Conference on Axiomatical Field Theory and Theory of Elementary Particles, Kiev, USSR.

The dynamical scheme of dispersion approach is applied to the theory of a neutral massive vector field interacting with a spinor one. The effects of the renormalization of wave functions are accounted for. Higher current-like operators and equal-time commutators of Heisenberg currents and fields are constructed. (auth)

15199 (ITF-68-42) ON THE STUECKELBERG FORMALISM FOR FIELD WITH SPIN 3/2. Stavraki, G. L. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1968. 5p. Dep.

The methods of constructing the Stueckelberg formalism for the Rarita–Schwinger field with spin 3/2 developed previously are compared. It is shown that one method in contrast to the other leads to the Stueckelberg formalism with subsidiary conditions invariant under the switch on the interaction. (auth)

15200 (ITF-68-55) NONLOCAL QUANTUM THEORY OF SCALAR FIELD. III. ESSENTIALLY NONLINEAR INTERACTION

LAGRANGIANS. Efimov, G. V. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1968. 43p. (In Russian). Dep.

It is shown that in the theory of a single-component scalar field the essentially nonlinear interaction lagrangian of the form $L_I(x) = -gU(\varphi(x)) = -g \sum_{m=3}^{\infty} (U_m/m!): \varphi^m(x):$ can be put in correspondence with the nonlocal S-matrix which is unitary and free from the ultraviolet divergences in any order of perturbation theory. (auth)

15201 (ITF-68-62) PROGRESS TOWARDS MODELS IN QUANTUM FIELD THEORY. Hepp, K. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1968. 18p. Dep.

The investigation of dynamical systems with particle nonconserving interactions is of great importance for proving the existence of nontrivial models in relativistic quantum mechanics. For the necessarily highly singular operations within and beyond Fock space new techniques in functional analysis are developed. It is hoped that these techniques will be the proper tools for sophisticated calculations in a future theory of elementary particles. (auth)

15202 INTRODUCTORY LECTURES ON DISPERSION RELATIONS. Diu, B. (CERN, Geneva). pp 71-111 of Methods in Subnuclear Physics. Vol. 2. Nikolic, M. (ed.). New York, Gordon and Breach, Science Publishers, Inc., 1968.

A brief discussion is first given of the mathematical and physical bases of dispersion relations—Cauchy's theorem and causality, respectively. The Lee model is studied to shed some light on the physical origin of the singularities of the S-matrix. The Mandelstam representation for spinless particles is discussed. It is then shown how one-dimensional dispersion relations may be obtained from it. Dispersion relations for π-N forward scattering are discussed as an example. (L.B.S.)

15203 CURRENTS AS DYNAMICAL VARIABLES. Sommerfield, Charles M. (Yale Univ., New Haven). Phys. Rev., 176: 2019-25(Dec. 25, 1968).

A dynamical theory of currents is presented. For each current there are a complete set of field equations and a complete set of equal-time commutators. These are related by expressing the energy-momentum tensor solely in terms of the currents and not of derivatives of the currents. The requirements of Lorentz covariance place severe restrictions on the commutators. Several models with and without internal symmetry are discussed. (auth)

15204 SUMS OF DIRECT-CHANNEL REGGE-POLE CONTRIBUTIONS AND CROSSING SYMMETRY. Khuri, N. N. (Univ. of California, Berkeley. Rockefeller Univ., New York). Phys. Rev., 176: 2026-33(Dec. 25, 1968).

Starting with a sequence of parallel rising trajectories in the s channel, examples are given of residue functions for which the Regge–Mandelstam pole contributions can be explicitly summed. The sum has Regge behavior in the s channel as well as the t channel, and satisfies fixed-t dispersion relations and finite-energy sum rules. The residue functions do satisfy the usual analyticity properties and threshold properties, have the Mandelstam symmetry factor, and show the expected exponential behavior for large $|s|$. These results are achieved without fixing either the slope or the intercept of the leading trajectory and without specifying Imα in detail in the low- and intermediate-energy region. These examples are used to clarify some of the problems related to the use of finite-energy sum rules, both as phenomenological relations and as dynamical equations. The way a finite but large number of s-channel resonances can be summed to give Regge behavior in s is explicitly demonstrated. It is also indicated how the observation by Schmid on the relation of the ρ-exchange contribution in pion-nucleon charge-exchange scattering to direct-channel resonances can be understood in terms of a direct-channel Regge–Mandelstam analysis. Finally, a general method is pointed out for generating more examples of other residue functions with the desired properties. (auth)

15205 RENORMALIZABLE THEORY OF THE WEAK INTERACTIONS. Christ, N. (Princeton Univ., N. J.). Contract AF491(638)-1545. Phys. Rev., 176: 2086-2100(Dec. 25, 1968).

A class of renormalizable field theories of the weak interactions is investigated. These theories, of the type first suggested by Kummer and Segrè, postulate that the weak interactions are mediated by the simultaneous exchange of two scalar particles. It is found that although the leptonic and semileptonic weak interaction can be fairly easily described by a two-scalar-exchange mechanism, the structure of observed nonleptonic weak processes presents serious obstacles to the success of such a theory. Nevertheless, two particular models are discussed which may correctly describe not only the leptonic and semileptonic weak interactions but also nonleptonic weak processes. (auth)

15206 POSSIBLE CLASSIFICATION OF EXCHANGE-DEGENERATE TRAJECTORIES. Ahmadzadeh, Akbar; Jacob, Richard J. (Arizona State Univ., Tempe). Phys. Rev., 176: 1719-23(Dec. 25, 1968).

A possible classification of nearly all the known mesons in terms of exchange-degenerate trajectories is given. This classification is consistent with the quark model and is also in general agreement with the behavior of the trajectories inferred from high-energy phenomenology. Predictions are made for the quantum numbers of some resonances. Arguments for the Lorentz-pole classification of these trajectories are also given. (auth)

15207 INTERACTING RARITA–SCHWINGER FIELD. Mohan, Gyan (Univ. of Denver). Phys. Rev., 176: 1931-3(Dec. 25, 1968).

To avoid the mutual inconsistency between interaction, quantization, and subsidiary conditions of the Rarita–Schwinger spin-$\frac{3}{2}$ field, an additional subsidiary field is introduced in the spirit of the Stückelberg formalism. Relativity is violated in the time development of the subsidiary field, but no observable consequences seem to follow. The unwanted states are removed invariantly from the asymptotic states through a Gupta–Bleuler kind of subsidiary condition. Energy has a positive-definite expectation value in the physical states. (auth)

15208 A $\lambda\varphi^4$ QUANTUM FIELD THEORY WITHOUT CUTOFFS. I. Glimm, James (Massachusetts Inst. of Tech., Cambridge); Jaffe, Arthur. Phys. Rev., 176: 1945-51(Dec. 25, 1968).

The dynamics for a local quantum field theory is constructed in two-dimensional space-time. The model describes a scalar field φ with a $\lambda\varphi^4$ self-interaction. In the Heisenberg picture, influence propagates at the speed of light. The resulting dynamics is independent of any cutoff, and hence the theory is formally Lorentz-covariant. (auth)

15209 INTERSECTING REGGE TRAJECTORIES IN A FIELD-THEORY MODEL. Swift, Arthur R. (Univ. of Massachusetts, Amherst). Phys. Rev., 176: 1848-55(Dec. 25, 1968).

The intersection of Regge trajectories in a field-theory model is investigated by means of high-energy perturbation-theory techniques. For a repulsive interaction, one of the three trajectories present in the pure ladder-diagram model near $l = -2$ intersects the pole originating at $l = -1$ and forms a conjugate pair of poles in a manner similar to that previously found in potential theory. When additional relativistic diagrams are mixed with the ladder diagrams, two of the secondary trajectories can intersect, encircle $l = -1$, and reach the physical region while the leading pole remains real and below $l = -1$. (auth)

15210 FEYNMAN DIAGRAMS. Barbashov, B. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 1-30 of Methods in Subnuclear Physics. Vol. 2. Nikolic, M. (ed.). New York, Gordon and Breach, Science Publishers, Inc., 1968.

The application of perturbation methods to the quantized theory of interacting relativistic fields is considered. The discussion is based on the formula for the S-matrix in the interaction representation. Feynman rules are formulated for writing down the matrix elements of the scattering matrix. The procedure for evaluating S-matrix elements for various scattering processes is discussed. As an example of the application of the method presented, the cross sections for Compton scattering are calculated in the first nonvanishing approximation. (L.B.S.)

15211 QUANTUM FIELD THEORY OF PARTICLES WITH BOTH ELECTRIC AND MAGNETIC CHARGES. Zwanziger, Daniel (New York Univ., N. Y.). Phys. Rev., 176: 1489-95 (Dec. 25, 1968).

The quantum field theory of particles with both electric and magnetic charges is developed as an obvious extension of Schwinger's quantum field theory of particles with either electric or magnetic charge. Two new results immediately follow. The first is the chiral equivalence theorem which states the unitary equivalence of the Hamiltonians describing the system of particles with electric and magnetic charges e_n, g_n and the system with charges $e'_n = \cos\theta\ e_n + \sin\theta\ g_n, g'_n = -\sin\theta\ e_n + \cos\theta\ g_n$. This result holds in particular in the absence of physical magnetic charges. The second result is that if physical magnetic charges do occur, then, in consequence of chiral equivalence, the charge quantization condition applies, not to the separate products $e_m g_n$, but to the combinations $e_m g_n - g_m e_n$, which must be integral multiples of 4π. The general solution of this condition leads to the introduction of a second elementary quantum of electric charge e_2, the electric charge on the Dirac monopole, besides the first elementary charge e_1, the charge on the electron. There are no other free parameters. (auth)

15212 EMISSION OF RADIATION FROM A SYSTEM OF MANY EXCITED ATOMS. Ernst, V.; Stehle, P. (Univ. of Pittsburgh). Phys. Rev., 176: 1456-79(Dec. 25, 1968).

The Weisskopf–Wigner theory of the natural linewidth of a single isolated atom is extended to a system of N (≫1) identical nonoverlapping atoms which are all in the same excited state at time t = 0. The positions $X_1 \ldots X_N$ of the atoms are assumed to fill a volume V of a given shape and size with macroscopically constant density. Emission of radiation from this system takes place only in the form of one narrow, but nonzero-width, bundle of nearly equal photons, which contains all the emitted radiation. If the density of atoms within V exceeds a certain threshold, the rate of emission of photons has the form of a typical spike. All effects depend sensitively on the shape and size of V and on the density of atoms within V, and cannot be explained in conventional terms of spontaneous or stimulated emission of radiation. (auth)

15213 DIFFICULTIES OF A QUANTUM FIELD THEORY OF ELECTRODYNAMICS. Strocchi, F. (Univ., Pisa, Italy. Istituto Nazionale di Fisica Nucleare, Pisa, Italy. Scuola Normale Superiore, Pisa, Italy). Nuovo Cim., Lett., 1: 169-73(Jan. 21, 1969).

A previous result, that if the vector potential is covariant and the Maxwell equations are operator identities on the vacuum state there is a contradiction whether or not indefinite metric is used, is generalized to admit the possibility that the vector potential may not be covariant under Lorentz transformations. The result can be regarded as showing that either nonlocal fields must be introduced (as in the Coulomb gauge) or Maxwell's equations must be abandoned as operator identities on the vacuum (as in the Gupta–Bleuler method) in order to obtain a quantum electrodynamics. (W.H.K.)

15214 DIFFERENT APPROACHES TO FIELD THEORY, ESPECIALLY QUANTUM ELECTRODYNAMICS. Kallen, G. (Univ. of Lund, Sweden). Proc. Conf. Phys., 14th, Univ. Brussels, 1967, 33-51(1968).

From 14th Conference on Physics, Brussels, Belgium. See CONF-671076.

A discussion is presented of calculational and other techniques developed for quantized field theories, including the original formulation of Lagrangian field theory, an alternative formulation of this theory, and more recent developments. (UK)

15215 MATHEMATICAL ASPECTS OF QUANTUM FIELD THEORY. Haag, R. (Univ., Hamburg). Proc. Conf. Phys., 14th, Univ. Brussels, 1967, 23-32(1968).

From 14th Conference on Physics, Brussels, Belgium. See CONF-671076.

Some questions in this field which have received fruitful collaboration between mathematicians and physicists during recent years are discussed. Among matters discussed are functional analysis, amplitudes for scattering and production processes, variational methods, perturbation methods, the Tamm–Dancoff method and the Bethe–Salpeter equation, nonrelativistic many body problems, classification of structures, the local quantum theory of an infinite system, symmetry groups, locality and causality, etc. (UK)

15216 INDEFINITE METRIC AND NON-LOCAL FIELD THEORIES. Sudarshan, E. C. G. (Syracuse Univ., N. Y.). Proc. Conf. Phys., 14th, Univ. Brussels, 1967, 97-127(1968).

From 14th Conference on Physics, Brussels, Belgium. See CONF-671076.

An historical account is given of the development and application of the quantum theory of fields. It is stated to be desirable to study the nature of a quantum field theory with local interaction densities in which the divergences which enter the usual formulation are avoided. The regularisation method of removing infinities (method of auxiliary masses) calls attention to the possibility of using a linear vector space with an indefinite form for the inner product as the space of state vectors, referred to as an "indefinite metric space," and to a quantum field theory in such a space, called an "indefinite metric field theory." A meaningful relativistic quantum field theory is developed with local interactions in an indefinite metric space. This theory yields transition amplitudes which have some superficial resemblance to those obtained by regularisation, but which are essentially distinct. The following matters are discussed: quantum theory in indefinite metric spaces; covariant Lagrangian theory and its "diseases"; conflict between covariance and locality in relativistic particle theories; covariant field theory in an indefinite metric space; particle motions in an interacting field theory; relation of indefinite metric theory to nonlocal theories, Heisenberg's theory; regularisation theory and its field-theoretic formulation; general field-theoretic questions. It is concluded that the use of the indefinite metric removes the divergence difficulties of field theories and removes mathematical ambiguities in the definition of the equations of motion, making it possible to consider a perturbation expansion of the predictions of the theory. The use of an indefinite metric may be viewed as a method of restricting the number of degrees of freedom of a field. It is suggested that the indefinite metric formulation of quantum field theory may be the prelude to a new theory in much the same way as the quantum hypothesis was the prelude to quantum mechanics, and it seems worthwhile to explore dynamical calculations in an indefinite metric quantum theory. (UK)

15217 DISSIPATIVE PROCESSES, QUANTUM STATES, AND FIELD THEORY. Prigogine, I. (Univ. of Brussels). Proc. Conf. Phys., 14th, Univ. Brussels, 1967, 155-202(1968).

From 14th Conference on Physics, Brussels, Belgium. See CONF-671076.

A study is described of quantum states and quantum levels corresponding to a finite lifetime, closely related to which is the question of a consistent dynamical description involving physical renormalized particles. Reasons are discussed as to why it is convenient to use the density matrix as a starting point. The general methods of nonequilibrium statistical mechanics are summarized, the interaction between radiation and matter is discussed, and the difficulties of including higher order terms in the coupling constant are indicated. A new transformation theory is presented, leading through a nonunitary process to a new description in which the dynamical evolution is simple and physically clear, this being very similar to the evolution of a weakly coupled system. At each moment the entropy of the system must be expressed through a simple Boltzmann type combinatorial expression, guaranteeing dealing with physical particles in the sense of field theory. States both with infinite lifetime and finite lifetime can be defined. The theory is applied to the interaction of radiation and matter, and it is shown that Einstein's classical theory of spontaneous transitions can be generalized to higher order in the coupling constant. An example is given for the explicit expression of an excited quantum state and quantum level including lifetime effects. Relation with field theory is discussed. It is shown that the method provides a generalization of improper unitary transformations for dissipative systems. The relation between quantum states and entropy is stated to take a remarkable new form. (UK)

15218 MAJORANA REPRESENTATIONS OF THE LORENTZ GROUP AND INFINITE-COMPONENT FIELDS. Stoyanov, D. Ts. (Joint Inst. for Nuclear Research, Dubna, USSR); Todorov, I. T. J. Math. Phys. (N. Y.), 9: 2146-67(Dec. 1968).

A self-contained exposition is given of the theory of infinite-component fields with special emphasis on fields transforming under the Majorana representations of the Lorentz group, for which the scalar vertex function is written down explicitly for particles with arbitrary momenta and spins. The problem of spin and statistics for such fields is analyzed. A class of coupled representations of SL(2,C) is studied, containing unitary as well as nonunitary representations (including the Dirac 4-component spinors), for which invariant first-order equations can be written down for the free field. Most of the results are known (either from old or from recent publications), but are presented here in a unified way, their derivation sometimes being simplified. Among the few new points mentioned are: (1) The location of singularities of the matrix elements of some infinite-dimensional representations of SL(2,C) for complex values of the group parameters. (2) The construction of an infinite-component local Fermi field transforming under a unitary representation of SL(2,C). (3) The discussion of the quantization of Majorana fields with a proper account of the Fourier components with spacelike momenta. (auth)

15219 ASYMPTOTIC FIELDS IN SOME MODELS OF QUANTUM FIELD THEORY. I. Hoegh-Krohn, Raphael (Univ. of Oslo). J. Math. Phys. (N. Y.), 9: 2075-80(Dec. 1968).

A quantum field with nonlocal interaction is considered. Under a proper smoothness condition on the interaction it is proven that the asymptotic limits of the annihilation–creation operators exist. The asymptotic limits are then used to prove that the state space decomposes as a tensor product of an incoming (outgoing) Fock space and a zero-particle space. (auth)

15220 BETHE–SALPETER EQUATION. Broido, Michael M. (Univ. of Kent, Canterbury, Eng.); Taylor, John G. J. Math. Phys. (N.Y.), 10: 184-209(Jan. 1969).

The Bethe–Salpeter equation is treated as a problem in singular integral equations. As such, it has three outstanding features: its algebraic structure, the fixed propagator singularities in the direct channel, and the possible singularities in the potential, which are usually moving singularities. The algebraic structure is exploited in order to give insight into the possible correctness classes for

the equation. Explicit prescriptions are given for the removal of fixed singularities in a wide class of equations. It is shown under what circumstances these prescriptions can be adapted to maintain such desirable features as symmetry of the kernel. Moving singularities arise in physically realistic kernels; they are the crossed-channel singularities. The basic mathematics of such singularities is well known and is related to the Riemann–Hilbert problem, but this is useless in off-shell methods because it cannot cope with the integration over the space parts of 4-momenta. Instead, a method (proposed by one of us elsewhere) is adopted based on analyticity in energy variables. The resulting formalism is too complicated to be applied in full generality. Therefore the example of the single-particle exchange potential is considered in detail, and it is shown how the moving singularities can be eliminated, exhibiting the resulting equations explicitly in a form to which the theory of fixed singularities can immediately be applied. All arguments are exact. (auth)

15221 DESER–GILBERT–SUDARSHAN SPECTRAL REPRESENTATION AND MATRIX ELEMENTS OF THE EQUAL-TIME CURRENT COMMUTATORS IN PERTURBATION THEORY. Usyukina, N. I. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 8: 1253-8(Dec. 1968). (In Russian).

The Deser–Gilbert–Sudarschan spectral representation for the matrix element $\langle p|[j^{\mu}_{\alpha}(x/2)j^{\nu}_{\beta}(-x/2)]|0\rangle$ in the lowest perturbative order is considered for a renormalizable quark model with primary interaction Lagrangian: $L_{int}(x) = g_s{:}\ \bar{\psi}(x)\psi(x)\varphi_s(x){:} + ig_p{:}\ \bar{\psi}(x)\gamma^5\psi(x)\varphi_p(x){:} + g_v{:}\ \bar{\psi}(x)\lambda^{\alpha}_{\alpha}\psi(x)a^{\alpha}_{\mu}(x){:}$. Basing on this representation the value of the matrix element $\langle p|[j^{\mu}_{\alpha}(x/2)j^{\nu}_{\beta}(-x/2)]|0\rangle$ at the equal times is considered. (auth)

15222 CATASTROPHIC EVENTS AND GAUGE INVARIANCE. Haller, Kurt (Univ. of Connecticut, Storrs); Landovitz, Leon F. Phys. Rev. Lett., 22: 245-7(Feb. 10, 1969).

Electromagnetic effects of catastrophic processes are examples of physical phenomena in which the usual treatment of the Lorentz gauge gives incorrect results. The recently proposed new formulation of the Lorentz gauge leads to results identical to those of the Coulomb gauge. (auth)

15223 INFRARED DIVERGENCES IN QUANTUM ELECTRODYNAMICS AND STATES WITH DEFINITE CHARGE PARITY. Nikishov, A. I.; Ritus, V. I. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz., 56: 380-7(Jan. 1969). (In Russian).

It is shown that for such processes as electron-positron annihilation from continuous spectrum states with definite charge parity, cancellation of infrared divergences in each order of perturbation theory does not occur. Hence the annihilation probability, which takes into account all radiative corrections and the emission of all real soft photons, ceases to depend on the regularization parameter (photon mass λ) not at $(\lambda/m^2) \ll 1$ as usual but at $(\lambda/m)^{2\alpha A} \ll 1$ where $\alpha = 1/137$ and $A \sim \ln(E/m)$. Consequently in the limit $\lambda \to 0$ the probability does not contain infrared divergences and in a real experiment in which the dimensions of the laboratory or experimental installation play the role of the parameter λ^{-1} the average number of emitted photons turns out to be of the order of unity and the probabilities for annihilation from states $C = +1$ and $C = -1$ depend on the laboratory dimensions and differ essentially from the respective Born expressions. (auth)

15224 STATISTICAL MECHANICS OF A SYSTEM OF INTERACTING BOSONS. Singh, K. K. (Univ., Groningen, Netherlands). Physica, 34: 285-309(1967).

The equilibrium properties of a system of interacting bosons are studied by the methods of quantum field theory. The problem is formulated in terms of a density matrix in an irreducible representation so as to be able to treat the degenerate as well as the nondegenerate phase. The quantities of basic interest are considered to be the one-particle, time-dependent Green's functions of the system from which the free energy can be obtained through suitable prescriptions. Explicit expressions are derived for the various thermodynamic functions in the weak-interaction approximation for the self-energy parts. To the first order in the interaction ν_0, the behavior of the thermodynamic functions is such as would correspond to a second-order phase transition across the line of condensation. To the order (ν_0^2), the specific heat diverges proportional to $(n-n_c)^{-\frac{1}{2}}$ as the density n approaches the critical density n_c from the degenerate phase. The inverse compressibility on the other hand becomes negative for densities sufficiently close to the critical density indicating that the weak interaction results, or the formally equivalent low density results, are valid in the neighborhood of the transition line in an asymptotic sense only. (auth)

15225 EQUAL-TIME COMMUTATORS FOR THE RENORMALIZED CURRENT IN QUANTUM ELECTRODYNAMICS. Lukierski, J. (Univ. of Wroclaw). Nuovo Cim., Lett., 1: 259-62(Feb. 11, 1969).

It is found that for interesting fields one should replace the notion of equal-time limit by a notion of equal-time singularity, described by a distribution-valued singular function. The nonexistence of the equal-time limit is characteristic for the relativistic as well as nonrelativistic local quantum field theory. The studies of the algebraic structure of the field operators not having the equal-time limit seems to be a necessary step in the development of the fundamentals of quantum field theory. (J.F.P.)

15226 ON THE VALIDITY OF THE SACHS–SCHWEBEL THEORY OF QUANTUM ELECTRODYNAMICS. Frank, B. (Sir George Williams Univ., Montreal). Nuovo Cim., Lett., 1: 242-4 (Feb. 1, 1969).

Two aspects of quantum electrodynamics developed by Sachs and Schwebel are examined from the point of view of internal consistence and the validity of the spinor solutions. These aspects are that based on an elementary interaction concept, the theory does not admit the source-free radiation field, and that it interprets positronium annihilation in terms of the dynamical properties of the particle-antiparticle pair in a ground state of zero energy–momentum (the annihilation state). (J.F.P.)

15227 ON THE CONVERSE OF THE REEH–SCHLIEDER THEOREM. Borchers, H. J. (Univ., Goettingen, Ger.). Commun. Math. Phys., 10: 269-73(1968).

It is shown that the weak additivity property is not only sufficient but also necessary for the derivation of the Reeh-Schlieder theorem. (auth)

15228 NEW PERSPECTIVES ON THE DIRAC HAMILTONIAN AND THE FEYNMAN PROPAGATOR. Ramakrishnan, Alladi (International Centre for Theoretical Physics, Trieste, Italy). pp 665-72 of High Energy Physics and Fundamental Particles. Barut, Asim O.; Brittin, Wesley E. (eds.). New York, Gordon and Breach, Science Publishers, 1968.

The Dirac theory is viewed in a new perspective in which the Dirac Hamiltonian is not limited to the domain of relativistic quantum mechanics, but is considered part of a larger structure. The Feynman propagator is also considered from an unconventional point of view, and a summation procedure is described. The results show that the electron-positron theory of Dirac implies the use of the Feynman propagator and not the other kernel solutions like the "advanced" and "retarded" functions. (L.B.S.)

15229 REMARKS ON RELATIVISTIC TWO-PARTICLE WAVE EQUATIONS. Raczka, R. (Inst. for Nuclear Research, Warsaw). pp 539-48 of High Energy Physics and Fundamental Particles. Barut, Asim O.; Brittin, Wesley E. (eds.). New York, Gordon and Breach, Science Publishers, 1968.

It is shown that at present an effective and consistent relativistic nonlinear quantum mechanics or quantum mechanics in curved spaces cannot be developed; the principal difficulty relates to the fact that nonlinear functional analysis is sparsely developed. The discussion is restricted to an analysis of a linear theory in flat space-time. The case of a two-fermion system is considered, and the linear relativistic Schroedinger-like wave equations are derived. (L.B.S.)

15230 HIGHER SPIN FIELDS. Mohan, Gyan (Univ. of Denver). pp 339-56 of High Energy Physics and Fundamental Particles. Barut, Asim O.; Brittin, Wesley E. (eds.). New York, Gordon and Breach, Science Publishers, 1968.

A formulation of free field theories for arbitrary spin is presented. Some remarks concerning an interacting system are given. (L.B.S.)

15231 FEYNMAN-PARAMETER REPRESENTATION OF OLD-FASHIONED PERTURBATION DIAGRAMS. Lam, C. S. (McGill Univ., Montreal). Nuovo Cim., 59A: 435-43(Feb. 21, 1969).

Feynman parameters are introduced to make it possible to integrate over the internal momenta of any noncovariant old-fashioned perturbation diagram. A set of rules to calculate any such perturbational amplitude in terms of Feynman parameters and external momenta alone is then formulated. Infinite-momentum frame is next considered and the resulting rules are interpreted with the help of the electric-circuit analogy. These rules may be considered as a further development of the Weinberg rules. (auth)

15232 RENORMALIZATION PROCEDURE IN FEYNMAN-PARAMETER REPRESENTATIONS. Lam, C. S. (McGill Univ., Montreal). Nuovo Cim., 59A: 422-34(Feb. 21, 1969).

Feynman-parameter representations of perturbational amplitudes were given in a previous paper. A recipe for the renormalization of such representations is given in this one. (auth)

15233 FEYNMAN-PARAMETER REPRESENTATIONS FOR MOMENTUM- AND CONFIGURATION-SPACE DIAGRAMS. Lam, C. S.; Lebrun, J. P. (McGill Univ., Montreal). Nuovo Cim., 59A: 397-421(Feb. 21, 1969).

Completely general rules for Feynman-parameter representations are given for both momentum- and configuration-space Feynman diagrams. They are applicable to derivative couplings, spin-endowed propagators, as well as simpler cases. All quantities appearing in these representations are interpreted in terms of network analogies. The application to the determination of asymptotic limits of Feynman integrals with spin is considered on an example. (auth)

Gravitation and General Relativity

Refer also to abstracts 14469, 14572, 14585, and 14594.

15234 MULTIPOLE PARTICLES IN EQUILIBRIUM IN GENERAL RELATIVITY. Szekeres, P. (King's Coll., London). Phys. Rev., 176: 1446-50(Dec. 25, 1968).

Axially symmetric static solutions of Einstein's equations with singularities on the z axis are considered. The structure of the singularities is more general than that considered previously by Bergmann, since higher multipole moments are now allowed. The equilibrium conditions for such multipole singularities in an external field are derived. It is shown that solutions having two or more such singularities on the axis may be found in abundance, independently of the signs of the masses of the particles. (auth)

15235 CHANGES OF THE PETROV TYPE OF A SPACE–TIME. Case, Lloyd A. (Brigham Young Univ., Provo, Utah). Phys. Rev., 176: 1554-7(Dec. 25, 1968).

A theoretical study is made of the "evolution" of a space-time of one Petrov type into another. The work "evolution" is used to mean that change of type which a point observer would consider his local space-time had experienced as a discontinuous front swept over him. The study is motivated by a desire to better understand the Petrov classification and thus improve its use as a tool to deal with solutions in general relativity. An algorithm is developed that may in principle be used to test the evolution of any closed-form solution known. A flow diagram is found which shows the routes that each Petrov type may use and the Petrov type of the discontinuity causing each change. During this development some results of the study of discontinuous hypersurfaces are found essentially equivalent to Trautman's information approach to waves, thus yielding further motivation for the use of the latter. The Weyl technique is understood as an important method for at least partially separating the coordinate and physical behaviors. (auth)

15236 KILLING HORIZONS AND ORTHOGONALLY TRANSITIVE GROUPS IN SPACE–TIME. Carter, Brandon (Univ. of Cambridge, Eng.). J. Math. Phys. (N.Y.), 10: 70-81(Jan. 1969).

Some concepts which have been proven to be useful in general relativity are characterized, definitions being given of a local isometry horizon, of which a special case is a Killing horizon (a null hypersurface whose null tangent vector can be normalized to coincide with a Killing vector field) and of the related concepts of invertibility and orthogonal transitivity of an isometry group in an n-dimensional pseudo-Riemannian manifold (a group is said to be orthogonally transitive if its surfaces of transitivity, being of dimension p, say, are orthogonal to a family of surfaces of conjugate dimension n−p). The relations between these concepts are described and it is shown that, if an isometry group is orthogonally transitive then a local isometry horizon occurs wherever its surfaces of transitivity are null, and that it is a Killing horizon if the group is Abelian. In the case of (n−2)-parameter Abelian groups it is shown that, under suitable conditions (e.g., when a symmetry axis is present), the invertibility of the Ricci tensor is sufficient to imply orthogonal transitivity; definitions are given of convection and of the flux vector of an isometry group, and it is shown that the group is orthogonally transitive in a neighborhood if and only if the circulation of convective flux about the neighborhood vanishes. The purpose is to obtain results which have physical significance in ordinary space–time (n = 4), the main application being to stationary axisymmetric systems; illustrative examples are given at each stage; in particular it is shown that, when the source-free Maxwell–Einstein equations are satisfied, the Ricci tensor must be invertible, so that Theorem 2 always applies (giving a generalization of the theorem of Papapetrou which applies to the pure-vacuum case). (auth)

15237 CURVATURE AND THE PETROV CANONICAL FORMS. Thorpe, John A. (Inst. for Advanced Study, Princeton, N. J.). J. Math. Phys. (N.Y.), 10: 1-7(Jan. 1969).

The Petrov classification for the curvature tensor of an Einstein space M^4 is related to the critical-point theory of the sectional-curvature function σ, regarded as a function on the manifold of nondegenerate tangent 2-planes at each point of the space. It is shown that the Petrov type is determined by the number of critical points. Furthermore, all the invariants in the canonical form can be computed from a knowledge of the critical value and the Hessian quadratic form of σ at any single critical point. (auth)

15238 VARIATIONAL PRINCIPLES FOR THE GRAVITATIONAL FIELD. Stephenson, G. (Imperial Coll. of Science and Tech., London). Nuovo Cim., Lett., 1: 97-9(Jan. 11, 1969).

The variational method in which the Riemann tensor is formed from the Christoffel connection is used to obtain the Einstein field equations with a cosmological term. (L.B.S.)

15239 GRAVITATIONAL WAVES IN GENERAL RELATIVITY THEORY. II. PLANE FRONT GRAVITATIONAL WAVES OF KUNDT. Dozmorov, I. M. (Moscow Higher Technical School). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 10, 17-21(1968). (In Russian).

The invariant theory of gravitational radiation, constructed by using the Rodichev energy–momentum tensor of the gravitational field is used to investigate an exact solution of the Einstein equations found by Kundt (Zeitschrift für Physik, 163: 77(1961)). It is concluded that in the general case these equations describe gravitational waves with sources. (tr-auth)

15240 GRAVITATIONAL WAVES IN GENERAL RELATIVITY THEORY. I. INVARIANT FORMULATION OF THEORY OF GRAVITATIONAL RADIATION. Dozmorov, I. M. (Moscow Higher Technical School). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 10, 13-17(1968). (In Russian).

The problem of gravitational radiation is investigated by means of the Rodichev energy–momentum tensor. The invariant criterion of the presence of radiation in space without sources is formulated. For the general case the question concerning the presence of radiation is resolved by the local investigation of the behavior of the energy–momentum tensor in the "accompanying tetrad." In addition the results were applied to the investigation of certain exact solutions of the Einstein equations. (tr-auth)

15241 CONTINUOUS GENERATION OF GRAVITATION RAYS. Kopvillem, U. Kh.; Nagibarov, V. R. (Physical-Technical Inst., Kazan). Zh. Eksp. Teor. Fiz., 56: 201-14(Jan. 1969). (In Russian).

Various means of generation and detection of gravitational scalar and tensor waves with aid of electromagnetic or sound generators under laboratory conditions are analyzed. It is suggested that the superradiative states of quantum systems be employed for generation of gravitational waves in the optical range. Circuits for detection of zero oscillations of the gravitational field are proposed. (auth)

15242 ON THE POSSIBILITY OF VERIFYING THE EQUIVALENCE PRINCIPLE (FOR THE ELECTROMAGNETIC FIELD) IN SECOND ORDER IN THE NEWTONIAN GRAVITATIONAL CONSTANT. Naida, O. N. JETP Lett. (USSR) (Engl. Transl.), 8: 68-70(July 1968).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 8: 110-13(July 20, 1968).

The equivalence principle is considered in the same sense as previously when it was shown that violation of the equivalence principle for atomic phenomena could lead to a specific observable effect in strong gravitational fields. If one considers a variant of the linear tensor theory of gravitation leading (for spherically symmetrical fields) to a tensor of spatially isotropic form, then the polarization effects arising as a result of the manner of violation of the equivalence principle are due not to the sun's gravitational field, but to the gravitational field of the revolving galaxy. (J.F.P.)

15243 EXACT SOLUTIONS OF EINSTEIN'S COSMOLOGICAL EQUATIONS. Trollope, J. R.; Smith, B. E. (Univ. of Alberta, Edmonton). Nuovo Cim., 59B: 125-36(Feb. 11, 1969).

A metric form which was derived in an investigation of the electromagnetic null field is subjected to Einstein's gravitational-field equations. The cosmological form of the field equations is used and a new class of solutions is obtained. It is shown that these solutions contain the Einstein and Schwarzschild–de Sitter solutions as special cases. A particular solution which appears to give rise to a generalization of the Schwarzschild metric is presented. (auth)

15244 SOME EXTENSIONS OF THE GENERAL-RELATIVISTIC PARTICLE MODEL. Sharma, N. K. (Univ. of Rajasthan, India). Nuovo Cim., 59B: 121-4(Feb. 11, 1969).

A stable model of a spherical charged particle in general relativity, based upon previous work, is proposed. If one identifies this particle with the electron one gets, in its lowest excited mode, an energy E equivalent to $137m_e$, which may be taken as the mass of the muon without spin. (auth)

15245 NEW DETERMINATION OF THE CONSTANT OF GRAVITATION. Cook, A. H. (National Physical Lab., Teddington, Eng.). Contemp. Phys., 9: 227-38(May 1968).

A new determination of the constant of gravitation is being undertaken more than 30 years after the previous determination. The reasons for undertaking a new determination are outlined, and the methods that have been adopted in the past are reviewed. The design of the new determination, which incorporates a number of refinements of principle and execution, is discussed. (auth)

Scattering Theory

Refer also to abstracts 14035, 15078, 15156, 15210, 15503, and 15520.

15246 (ITF-68-30) NEW PROOF OF POMERANCHUK THEOREM. Lomsadze, Yu. M.; Tokar, S. S.; Kontrosh, E. E. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1968. 13p. (CONF-680453-6). Dep.

From 2nd Conference on Axiomatical Field Theory and Theory of Elementary Particles, Kiev, USSR.

Based on the modified Meyman theorem 3, a new proof of the Pomeranchuk theorem is given under the assumption that the difference of the amplitudes $A_+(E)$-$A_-(E)$ increases slower than E ln E. In contrast to the existing proofs of this theorem, in the new proof no additional mathematical assumptions are used, except for that of the absence of very strong oscillations of $\Delta\delta = \delta_+(E)-\delta(E)$ in an accurately formulated meaning. One takes into account, in particular, that the amplitudes $A_\pm(E)$ for real E are distributions rather than usual functions. Two other formulations of the Pomeranchuk theorem are also given, one of which weakens still more the restrictions on possible oscillations of $\Delta\delta(E)$ and the other contains no restrictions on these oscillations whatsoever. (auth)

15247 (ITF-68-40) MODELS OF LOW-ENERGY SCATTERING WITH SHORT-RANGE REPULSION. Chermalykh, G. N. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1968. 8p. (In Russian). (CONF-680453-3). Dep.

From 2nd Conference on Axiomatical Field Theory and Theory of Elementary Particles, Kiev, USSR.

The dependence of the solutions for the models of low-energy scattering with short-range repulsion on the form of two-parameter effective nonlocal form factors is considered. It is shown that with a growing rate of the decrease of the form factor impulse Fourier-transform at infinity, the interval of permissible negative values for the scattering lengths extends noticeably, i.e., the low-energy description with two-parameter account for high-energy contributions is, in general, not closed. (auth)

15248 (ITF-68-41) DERIVATION OF PARTIAL-WAVE AMPLITUDES WITH CORRECT THRESHOLD BEHAVIOR. Chermalykh, G. N. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1968. 9p. (CONF-680453-4). Dep.

From 2nd Conference on Axiomatical Field Theory and Theory of Elementary Particles, Kiev, USSR.

Modifications of the Froissart inelastic function are suggested, allowing one to derive the partial-wave amplitude with the correct threshold behavior by the Froissart N/D-method. The possibility is discussed of deriving the correct threshold behavior of the partial-wave amplitudes $A_l(\nu)$ from the dispersion relations for $A_l(\nu)/W_l(\nu)$, $W_l(\nu) \sim \nu^l$ being threshold functions with the left-hand cut, $W_l(\nu) = \overline{0}(\nu)$, $\nu \to \infty$. (auth)

15249 GENERAL PARAMETRIZATION OF TRAJECTORY AND RESIDUE FUNCTIONS FOR DAUGHTER REGGE POLES. Durand III, Loyal; Fishbane, Paul M.; Simmons, L. M. Jr. (Univ. of Wisconsin, Madison). Phys. Rev. Lett., 22: 261-5(Feb. 10, 1969).

The most general parametrizations for the trajectory and residue functions for daughter Regge poles which are consistent with analyticity and unitarity are presented. Results are confined to the scattering of spinless particles, but are valid for arbitrary external masses and nonparallel trajectories. It is shown that except in the special case of pairwise-equal external masses, an infinite number of Lorentz poles contribute to the scattering amplitude at s = 0. A simple parametrization of the scattering amplitude for $s \sim 0, t \to \infty$ is obtained, which involves powers of both t and ln t. (auth)

15250 QUASISTABLE POMERANCHUK POLE AND DIFFRACTION SCATTERING AT SUPERHIGH ENERGIES. Gribov, V. N.; Migdal, A. A. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz., 8: 1213-26(Dec. 1968). (In Russian).

Diffractional scattering at superhigh energies s is analyzed assuming that the Pomeranchuk pole is quasistable at small momentum transfers t. It is shown that with this assumption the scattering amplitude at zero momentum transfer (t = 0) is represented as a series over inverse degrees of ln s. A lower estimate for the first correction of the order $(\ln s)^{-1}$ is found. It is shown that the cross section should approach the asymptotical limit from below and that the real part of the amplitude is positive at very high energies. The Pomeranchuk pole transforms into a pair of complex conjugated poles at negative t. The related branch points also became complex conjugated and condensate near the point j = 1. The asymptotics at low t and $t \ln s \lesssim 1$ is investigated in some detail. It is shown that at $t \ln s \gg 1$ the amplitude has the Orear's form and oscillates. The consideration is purely theoretical in the sense that the energies are arbitrarily high. (auth)

15251 PROPOSED TEST OF TOLLER ω DEPENDENCE OF TWO-REGGEON-ONE-PARTICLE VERTEX FUNCTIONS. Morrow, Richard A. (Dartmouth Coll., Hanover, N. H.). Phys. Rev., 176: 2147-53(Dec. 25, 1968).

It is argued that a particular distribution, in the Toller ω variable, of data from two- to three-particle reactions plausibly described by the double-Regge model, covering a wide range of energies, is flat if the two-Reggeon-one-particle vertex function in the amplitude is independent of ω. A prescription for selecting events useful for the test is given, and an estimate of the fraction of events thus selected is made. (auth)

15252 RELATION BETWEEN THE DAMPING OF LARGE TRANSVERSE MOMENTA IN ELASTIC AND INELASTIC COLLISIONS FROM UNITARITY. Narayan, D. S. (Tata Inst. of Fundamental Research, Bombay). Phys. Rev., 176: 2154-9(Dec. 25, 1968).

It is shown from the unitarity relation that the damping of large transverse momenta in inelastic collisions necessarily implies their damping in elastic collisions. In this derivation it is assumed that an inelastic amplitude can be written as a product of a slowly varying factor which depends only on incident energy and the longitudinal components q_i^L of the momenta q_i and another factor which incorporates the exponential damping of transverse momenta. (auth)

15253 MAXIMUM NUMBER OF BINARY COLLISIONS FOR THREE RELATIVISTIC POINT PARTICLES. Doolen, G. (Goddard Space Flight Center, Greenbelt, Md.). Phys. Rev., 176: 1541-3(Dec. 25, 1968).

As a step toward understanding relativistic rescattering singularities, the maximum number of binary collisions allowed by special relativity among three particles with zero-range forces is examined. It is found that for three equal-mass particles $n_{max} = 3$. However, for three particles with masses $m_1 = m_3 = 1$ and $m_2 < 1$, n_{max} decreases with increasing total energy W from its nonrelativistic value, which is between ∞ and 4, to its final value of 4, when $W > 1/m_2$. (auth)

15254 REGGE SECONDARY TRAJECTORIES. Fox, G. C.; Sertorio, L. (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev., 176: 1739-56(Dec. 25, 1968).

A systematic study of isospin-one exchange reactions leads to the proposal of additional singularities in the j plane of this channel. Such an analysis gives rise to several extra predictions to be tested in future experiments. (auth)

15255 UPPER AND LOWER BOUNDS ON SCATTERING LENGTHS FOR STATIC POTENTIALS. Arthurs, A. M. (Univ. of York, Eng.). Phys. Rev., 176: 1730-3(Dec. 25, 1968).

New upper and lower bounds on scattering lengths for static potentials are presented. The derivation is based on complementary variational principles for Fredholm integral equations of the type $p(r)\varphi(r) = f(r) - \int K(r,r')\varphi(r')dr'$ with symmetric, positive-definite kernels. (auth)

15256 OFF- AND ON-SHELL ANALYTICITY OF THREE-PARTICLE SCATTERING AMPLITUDES. Brayshaw, D. D. (Rockefeller Univ., New York). Phys. Rev., 176: 1855-70 (Dec. 25, 1968).

Off-shell analytic properties are obtained for amplitudes which satisfy approximate three-body equations of the Faddeev-Lovelace type. These properties are used to construct an explicit representation for the off-shell three-particle amplitude in terms of the solution of a new integral equation. The advantages of this

new equation for both analytical and computational purposes are discussed, and the representation is used to determine on-shell analyticity for the amplitude. The form of the representation is such that the important three-body singularities are exhibited in a particularly transparent fashion. (auth)

15257 CONSPIRACY AND COUNTERCONSPIRACY IN EQUAL-MASS SCATTERING. Weis, J. H. (Univ. of California, Berkeley). Phys. Rev., 176: 1822-34(Dec. 25, 1968).

Group theory provides an elegant general solution of the equal-mass conspiracy conditions but leaves open the possibility of a "counterconspiracy" between a number of integrally spaced Lorentz poles. It is shown that factorization of Regge-pole residues and coupling to channels of arbitrarily high spin imply that only one counterconspiracy (consisting of an infinite number of Regge poles) is possible in equal-mass scattering. It is also shown that, if there is coupling to unequal-mass channels, then even this counterconspiracy is forbidden and the only possible solution is for the equal-mass channel residues to be those of a single Lorentz pole. (auth)

15258 KINEMATIC SINGULARITY STRUCTURE OF AMPLITUDES FOR A FOUR-PARTICLE PROCESS WITH ONE MASSLESS PARTICLE. Cosslett, S. R. (Cambridge Univ., Eng.). Phys. Rev., 176: 1782-95(Dec. 25, 1968).

For a two-to-two particle interaction, one of the particles being massless, the kinematic-singularity-free combinations of helicity amplitudes, the constraint equations, and an expression for invariant amplitudes in terms of helicity amplitudes are discussed. The constraint equations are obtained from an invariant-amplitude expansion rather than from the crossing matrix. (auth)

15259 FACTORIZATION, KINEMATIC SINGULARITIES, AND CONSPIRACIES. Arbab, Farzam; Jackson, J. D. (Univ. of California, Berkeley). Phys. Rev., 176: 1796-1808(Dec. 25, 1968).

Factorization of residues of poles of the S matrix is derived from the requirements of unitarity for partial-wave helicity amplitudes. Careful attention is given to questions of spin and the kinematic singularities of the relevant amplitudes, especially at $t = 0$. Residues β of a pole in the full partial-wave amplitude satisfy factorization in the simple form $\beta_{ba}^2 = \beta_{aa}\beta_{bb}$. In general, β can be written as $\beta = K\gamma$, where K contains the standard kinematic singularities of the Hara-Wang type, plus threshold behavior, and γ is a reduced residue. The K's for various mass classes are exhibited in a compact and consistent form, and the corresponding factorization statements for the reduced residues are derived. These factorization relations are of the form $t^x\gamma_{ba}^2 = \gamma_{aa}\gamma_{bb}$, where x is an integer. The reduced residues are analytic in the neighborhood of thresholds and pseudothresholds, but may, in the case of conspiracies, contain poles at $t = 0$. Various examples are presented to illustrate the use of factorization. These include LeBellac's argument on the behavior of the pion residue at $t = 0$ and its circumvention with a type-II conspiracy. Mandelstam's treatment of Adler's self-consistency condition and the hypothesis of partially conserved axial-vector current using an $M = 1$ pion is discussed from the viewpoint of factorization. It is shown that factorization for an $M = 1$ pion seems to imply smallness of both soft-pion and hard-pion amplitudes. The smallness of the latter casts some doubt on the $M = 1$ assignment for the pion. The nature of the relations between amplitudes and the behavior of the reduced residues at $t = 0$ for conspiracies with unequal masses is also considered. (auth)

15260 MULTI-REGGEON BEHAVIOR OF PRODUCTION AMPLITUDES. Drummond, I. T. (Cambridge Univ., Eng.). Phys. Rev., 176: 2003-13(Dec. 25, 1968).

Gribov's approach is used to investigate the asymptotic properties of production amplitudes. When it is applied to an analysis of double Reggeon exchange, the results of previous authors are confirmed. In particular, it is verified that the amplitude $f_{\alpha_1\alpha_2}$ for the coupling of two Reggeons, α_1 and α_2, to a particle (of mass M) depends not only on the masses $q_i'^2$ and $q_j'^2$ of the Reggeons, but also on $q_3^2 = (q_i' - q_j')^2$. (Primed vectors are spacelike and perpendicular to the incident beam.) On the basis of a diagrammatic model, the dependence of $f_{\alpha_1\alpha_2}$ on q_3^2 is elucidated. When $M = m_\pi$, a strong variation of $f_{\alpha_1\alpha_2}$ throughout the physical region is expected. The same approach is applied to an analysis of a Reggeon triangle graph. Gribov's rules are found to apply provided that certain extra factors are included in the integrand. Because of these factors, the Reggeon "Ward identity" suggested by Anselm and Dyatlov no longer holds. The analytic structure of the corresponding double partial-wave amplitude is investigated. It has ordinary two-Reggeon singularities in each angular momentum separately, together with a leading curve depending on both variables. For the triangle graph, it turns out that the leading curve determines the asymptotic behavior, which is of the form $s^J/\ln s$, where the exponent J depends on q_3^2 as well as on $q_i'^2$ and $q_j'^2$. This type of behavior has no analog in two-body scattering, and it would be of interest to identify such behavior experimentally. Finally, it is pointed out that underlying the definition of the approximate double partial wave used in this paper is the asymptotic simplicity of analytic structure in energy variables of the production amplitude. (auth)

15261 REGGE ASYMPTOTIC BEHAVIOR AND THE BETHE-SALPETER EQUATION. Brandt, Richard A.; Feinroth, Martin (Univ. of Maryland, College Park). Phys. Rev., 176: 1985-97 (Dec. 25, 1968).

Under certain assumptions, the limit of the Bethe-Salpeter equation is taken at high energy (s) for the elastic scattering amplitude A (s,t) in $g\phi^3$ theory. For a large class of planar kernels behaving like $I(t)s^{-q}(\ln s)^p$, with integer $p \geq 0$ and $q \geq 1$, a Volterra equation for the asymptotic amplitude is obtained. The unique solution is of the Regge form $s^{\alpha(t)}$, with $\alpha(t) = -q + [p!K_q(t)I(t)]^{1/(p+1)}$. Here K_q is an explicit function, independent of g. This result agrees with that obtained by summation of leading asymptotic behaviors in each order of perturbation theory in all known cases. The assumptions for the ladder approximation are explicitly justified. In this case an integral equation is obtained for the exact $\alpha(t)$ which agrees with the usual result to order g^2. A discussion is given of nonplanar kernels in the formalism. (auth)

15262 CONNECTION BETWEEN THE TOLLER QUANTUM NUMBER M AND THE SMALL-t BEHAVIOR OF THE ASYMPTOTIC S-CHANNEL HELICITY AMPLITUDES. Gunion, John F.; Lipinski, H. M. (Univ. of California, San Diego, La Jolla). Phys. Rev., 176: 2045-6(Dec. 25, 1968).

Using a group-theoretic decomposition of the scattering amplitude, it is shown that the quantum number M introduced to ensure factorization of the asymptotic s-channel helicity amplitudes is precisely the Toller quantum number. (auth)

15263 O(4) EXPANSION OF OFF-SHELL SCATTERING AMPLITUDES. Frazer, W. R.; Halpern, F. R.; Lipinski, H. M.; Snider, D. R. (Univ. of California, San Diego, La Jolla). Phys. Rev., 176: 2047-53(Dec. 25, 1968).

Using an off-mass-shell approach, a method is developed for the O(4) expansion of the scattering amplitude for two unequal-mass, arbitrary-spin particles. General-spin spherical harmonics for O(4) are constructed. With the aid of these spherical harmonics, the M amplitude is decomposed into O(4) partial waves. The prescription for obtaining the on-mass-shell helicity states from the O(4) partial waves is given. This O(4) expansion, which is valid even away from $t = 0$, is useful in simplifying the Bethe-Salpeter equation. (auth)

15264 LORENTZ POLES AND BETHE-SALPETER EQUATIONS: DOES AN INFINITE NUMBER OF LORENTZ POLES EXIST? Chang, N. P.; Saxena, R. P. (City Coll., New York). Phys. Rev., 176: 2101-7(Dec. 25, 1968).

The possibility of the existence of an infinite family of Lorentz poles is investigated using a dynamical model. For spinless scalar particles (mass m) scattering via the exchange of another spinless scalar particle (mass μ), the Bethe-Salpeter equation is solved in two limiting cases, $\mu = 0$ and $\mu \to \infty$. In both cases it is shown that the O(4) projected amplitude is meromorphic in n (the four-dimensional angular momentum) and that there are an infinite number of poles in the n plane. (auth)

15265 S-MATRIX. Michael, C. (Oxford Univ.). pp 31-69 of Methods in Subnuclear Physics. Vol. 2. Nikolic, M. (ed.). New York, Gordon and Breach, Science Publishers, Inc., 1968.

The use of the S-matrix in quantum mechanics is discussed. The restrictions imposed by Lorentz invariance are described. The number of independent variables and amplitudes is discussed for various processes and conserved quantum numbers such as charge, isospin, or SU(3) spin are introduced. Phase space is shown to be a useful experimental tool to separate the dynamics of a process from the well understood kinematics, and cross sections are calculated in terms of S-matrix elements. Unitarity is discussed. The optical theorem is derived for forward elastic scattering and the partial wave decomposition is justified from unitarity, with a relativistic formulation. The concept of analyticity is introduced into S-matrix theory. Finally, single particle singularities and more general types of singularities are discussed. (L.B.S.)

15266 PHASE SHIFT ANALYSIS. Waloschek, P. (Istituto Nazionale di Fisica Nucleare, Bologna). pp 201-63 of Methods in Subnuclear Physics. Vol. 2. Nikolic, M. (ed.). New York, Gordon and Breach, Science Publishers, Inc., 1968.

The method of phase shift analysis for scattering problems is discussed in detail. The discussion includes scattering formulas, techniques used for analysis of experimental data, and experimental data on pion-pion and pion-proton scattering. The appendix includes units, kinematics of two-body reactions, and $\pi + N$ phase shifts up to 2 GeV. (L.B.S.)

15267 REGGEIZED RESONANCE MODEL FOR THE PRODUCTION AMPLITUDE. Bardakci, K. (CERN, Geneva); Ruegg, H. Phys. Lett., 28B: 342-7(Dec. 23, 1968).

A generalization is presented of Veneziano's model to the five particle (production) amplitude. The amplitude consists of multiple resonance exchanges and shows multi-Regge behavior in all channels. The residues at the poles have the correct polynomial dependence on the momentum transfer variables. The model also has partial crossing symmetry. Some conclusions and possible applications are pointed out. (auth)

15268 ANALYTICITY IN MASS VARIABLES AND LORENTZ POLES IN ARBITRARY-MASS SCATTERING. Kuo, P. K. (Johns Hopkins Univ., Baltimore). Phys. Lett., 28B: 339-41(Dec. 23, 1968).

It is demonstrated that if the scattering amplitude for spinless particles with arbitrary masses is analytic in t, $m_1^2 - m_3^2$ and $m_4^2 - m_2^2$ and is dominated by a family of Regge poles with factorizable residues, then it is given by a single Lorentz pole at $t = 0$. (auth)

15269 SATURATION OF HIGH-ENERGY FORWARD ELASTIC AMPLITUDES WITH AN INFINITE-RESONANCE MODEL. Predazzi, E. (Univ., Turin); Lasinski, T.; Levi Setti, R. Contract AF 49(638)-1652. Nuovo Cim., 59A: 263-79(Jan. 21, 1969).

The possibility that the elastic amplitudes in the asymptotically large energy domain could be dominated by the exchange of an infinite set of resonances in the direct channel is discussed. A few examples are presented suggesting that this infinite-resonance model can very easily, but not uniquely, account in particular for the appearance of the small-angle diffraction peak or Regge-like behavior in the forward direction. Whereas this nonuniqueness of the solution is one shortcoming of the model, it permits sufficient flexibility so that one may perhaps be able to reproduce the forward high-energy angular distribution once sufficiently reliable functional dependences for the resonant parameters are found. The sufficiency conditions on the partial-wave amplitudes for the elastic amplitudes to be exponential functions of t over the whole angular domain are also derived under the rather restrictive conditions that, as $s \to \infty$, the elastic amplitudes become entire functions of t. Even in this restrictive case the infinite-resonance model does not seem to possess a unique solution, but presumably very detailed information on the behavior of the amplitude when $s \to \infty$ might make the solution unique. (auth)

15270 STATISTICAL MODEL FOR HIGH-ENERGY ELASTIC SCATTERING AT ALL ANGLES. Humble, S. (Univ. of Colorado, Boulder). Nuovo Cim., Lett., 1: 155-62(Jan. 21, 1969).

A statistical model which describes the angular distributions of high-energy elastic-scattering processes at all angles is presented. No account is taken of internal quantum numbers or even spin. (W.H.K.)

15271 S-MATRIX THEORY WITH REGGE POLES. Chew, G. F. (Univ. of California, Berkeley). Proc. Conf. Phys., 14th, Univ. Brussels, 1967, 65-95(1968).

From 14th Conference on Physics, Brussels, Belgium. See CONF-671076.

The idea of a nuclear theory based directly on the S-matrix dates back to Heisenberg (1943). The motivation then, as now, was to avoid unobservable local space-time concepts which become troublesome when quantum principles are combined with relativity. A brief historical account of development of the theory is given, together with an appraisal of the current position under the following headings: maximal analyticity of the first degree; second degree analyticity; monotonic Regge trajectories; mystery of the small pion mass; the Pomeranchuk trajectory; the multi-Regge-pole hypothesis; Regge daughters and conspiracy. The importance of experimental work in this field is emphasized. (UK)

15272 DIFFERENTIAL EQUATIONS FOR HALF-OFF-SHELL MATRIX ELEMENTS. Sobel, M. I. (Atomic Energy Research Establishment, Harwell, Eng.). J. Math. Phys. (N. Y.), 9: 2132-7 (Dec. 1968).

A first-order differential equation is found for the quasiphase parameter which describes the half-off-shell scattering matrix. The quasiphase is given as $\Delta(\infty)$, where $\Delta(r)$ obeys an equation involving the potential but not the wavefunction and $\Delta(0) = 0$. The equation is used to develop low-momentum expansions for Δ, and to derive upper and lower bounds for the expansion parameters. (auth)

15273 CAYLEY TRANSFORM OF THE S MATRIX. Landshoff, P. V. (Univ. of Cambridge, Eng.). J. Math. Phys. (N. Y.), 9: 2279-82(Dec. 1968).

The requirement that the S-matrix be unitary is expressed in simple form by use of its Cayley transform (K matrix), which is also of value for practical computations. Here the physical-region structure of the K matrix is analyzed, and it is used to derive the nature of the "simple" physical-region singularities of the S-matrix. (auth)

15274 CLASS OF SOLUTIONS OF THE PHYSICAL 3-PARTICLE UNITARITY EQUATIONS IN STATIC S-MATRIX THEORY. Lebrun, Jean-Pierre (McGill Univ., Montreal). J. Math. Phys. (N. Y.), 9: 2211-25(Dec. 1968).

A class of formal exact solutions of the 3-particle unitarity equations are obtained under the restriction that the S matrix be invariant under a contraction of the Poincaré group known as the static limit. The main tool is the study of a homogeneous, multidimensional, Riemann–Hilbert boundary-value problem in the complex plane of a subenergy variable. It allows one to construct an ansatz for the S matrix that satisfies the four sets of 3-particle unitarity equations recurrently; i.e., the sets of Eqs. (II), (III), and (IV) are automatically satisfied, provided that (I) is satisfied. The set (I) is then reduced to a nonlinear boundary-value problem on the inelastic cut in the complex energy plane of the scattering amplitudes. The most general solution is obtained in terms of a particular solution; an algorithm is then described that produces such a particular solution. Finally, the relation of crossing to our exact 3-particle unitary S matrix is discussed. (auth)

15275 ANALYTICITY OF THE ENVELOPE DIAGRAMS. Risk, Clifford (Massachusetts Inst. of Tech, Cambridge). J. Math. Phys. (N. Y.), 9: 2168-72(Dec. 1968).

Analyticity of the envelope and open envelope diagrams is investigated, and solutions to the Landau equations are obtained which do not satisfy the usual symmetry property. The Landau curves which these solutions generate are found to have the following characteristics when the anomalous thresholds are on the unphysical sheet: they are also on the unphysical sheet; they have asymptotes that depend on the external masses of the diagrams; the Landau curve for the envelope diagram has as an asymptote a line u = const, although the diagram has no u channel; a new type of effective intersection is found. (auth)

15276 DETERMINATION OF THE AMPLITUDE FROM THE DIFFERENTIAL CROSS SECTION BY UNITARITY. Newton, Roger G. (Indiana Univ., Bloomington). J. Math. Phys. (N. Y.), 9: 2050-5(Dec. 1968).

Banach-space fixed-point theorems are used to prove two results: (a) If the differential scattering cross section is smooth and small enough, relative to the wavelength of the relative motion of the colliding particles, there always exists an amplitude function which satisfies elastic unitarity and whose squared modulus equals a given differential cross section. (b) Under somewhat stronger conditions this amplitude is uniquely determined (except for the sign of its real part) by the generalized optical theorem (unitarity) and it can be constructed by iterating the latter. The condition for (a) ensures a priori that the real part of the amplitude cannot vanish at any angle, and that for (b) implies that its real part cannot be smaller than twice its imaginary part. These results are then generalized to inelastic and production processes. (auth)

15277 REGGE TRAJECTORIES OF THE BETHE–SALPETER EQUATION IN THE WEAK-COUPLING LIMIT. Caneschi, L. (Univ. of California, Santa Barbara). Nuovo Cim., Lett., 1: 70-4 (Jan. 11, 1969).

The weak-coupling limit of Regge trajectories in the Bethe–Salpeter equation is studied in the framework of O_4 symmetry for scattering of two scalar mesons. (L.B.S.)

15278 CALCULATION OF COMPLEMENTARY BOUNDS FOR SCATTERING LENGTHS. Anderson, N.; Arthurs, A. M. (Univ. of York, Helsington, Eng.). Nuovo Cim., Lett., 1: 119-20(Jan. 11, 1969).

Calculations are made of upper and lower bounds of scattering lengths for the potential $V(r) = e^{-\beta r}/r$ using an integral-equation approach and a differential-equation approach. (L.B.S.)

15279 FIXED POLES IN MANY-CHANNEL, TWO-BODY SCATTERING AMPLITUDES. Fujisaki, H. (Tokyo Univ.). Nuovo Cim., Lett., 1: 123-4(Jan. 11, 1969).

Two-body scattering processes are examined to determine

whether or not fixed poles are generally ruled out by unitarity when there are fixed branch points due to spin kinematics. (W.H.K.)

15280 GENERALIZED LEVINSON'S THEOREM AND THE N/D FACTORIZATION WITH INELASTICITY. Cronstroem, C. (Univ. of Helsinki). Nuovo Cim., 59A: 249-62(Jan 21, 1969).

The general properties of the denominator function (in the N/D factorization) of an elastic-scattering amplitude are discussed for spinless equal-mass particles. The Levinson's theorem for the real part of the phase shift is shown to follow in a simple manner from the conditions on the denominator function. Special attention is paid to the case where the inelasticity function $\eta(s)$ has a finite number of zeros above the inelastic threshold. Then, the construction of the appropriate denominator function leads to a discontinuous Hilbert problem. It is shown that the denominator function must in general have square-root singularities at the positions of the zeros of the function $\eta(s)$. The generalized Levinson's theorem now relates the real part of the phase shift at infinity (or threshold), the number of stable-particle poles, the number of CDD poles, and a certain number which depends on the number of zeros of the function $\eta(s)$. It appears possible that the formalism discussed can be applicable to the problem of obtaining equivalence between single- and multichannel N/D calculations without CDD ambiguities. (auth)

15281 EXTENSION OF THE VENEZIANO FORM TO N-PARTICLE AMPLITUDES. Goebel, C. J.; Sakita, B. (Univ. of Wisconsin, Madison). Phys. Rev. Lett., 22: 257-60(Feb. 10, 1969).

The extension of Veneziano's form V(s,t) to the N-particle amplitude is given. (auth)

15282 REGGE FAMILIES IN THE WICK–CUTKOSKY MODEL. EXTENSION OF PREVIOUS RESULTS. Gatto, R. (Univ., Padua. Istituto Nazionale de Fisica Nucleare, Padua); Menotti, P. Nuovo Cim., Lett., 1: 289-94(Feb. 11, 1969).

An extension is made for previous results for Regge families in the Wick–Cutkosky model. It is found that with a slight modification, the treatment can be extended to the region $\eta^2 > 1$ above the physical threshold. As $\eta^2 \to \pm\infty$ all even time-parity Regge poles retreat uniformly to the left of the line Re $n = \alpha + 1$ and the odd time-parity Regge poles to the left of the line Re $n = \alpha$, with $\alpha > -1$. Cutkosky–Deo collisions for Re $n < -1$ are exhibited by the perturbative expressions of the trajectories and rigorously occur in the region Re $n < -1$ for λ sufficiently small but finite. For Re $n > 0$, $\eta^2 < 1$ no collision can occur among Regge trajectories. Also the Domokos formula for the derivatives of the trajectories breaks down due to the mixing in the degenerate solutions of different representations of Lorentz 0(4). A direct evaluation of the derivatives of all trajectories is given. (J.F.P.)

15283 O_4 SYMMETRIC PADE APPROXIMANTS. Caneschi, L. (Univ. of California, Santa Barbara). Nuovo Cim., Lett., 1: 219-22(Feb. 1, 1969).

A method is proposed that, in agreement with Padé approximants, incorporates O_4 symmetry and permits the slopes of the various trajectories at $t = 0$ to be computed. (J.F.P.)

15284 INTEGRAL EQUATIONS FOR THE NONRELATIVISTIC SCATTERING AMPLITUDES. Komarov, V. V.; Popova, A. M. (Moscow State Univ.). Phys. Lett., 28B: 476-9(Jan. 20, 1969).

A method of derivation of integral equations of the Fredholm type for N-particle scattering amplitudes based on time-dependent theory and the second quantization formalism is proposed. The method corresponds to the nonrelativistic diagram summation technique introduced by authors earlier for obtaining the equations for the case $N = 3$ and $N = 4$. (auth)

15285 EXPLICIT CONSTRUCTION OF THE N-POINT FUNCTION IN THE GENERALIZED VENEZIANO MODEL. Chan, Hong-mo; Tsun, Tsou Sheung (CERN, Geneva). Phys. Lett., 28B: 485-8(Jan. 20, 1969).

A previous conjecture for constructing the N-point function in the generalized Veneziano model is proved, and the explicit solution given. In addition to having the usual properties of Veneziano-type amplitudes, the result is shown (i) to satisfy bootstrap consistency in treating all particles as bound states of others, and (ii) to yield the decay correlations for particles with spins. (auth)

15286 INFINITE SERIES REPRESENTATION OF THE N-POINT FUNCTION IN THE GENERALIZED VENEZIANO MODEL. Hopkinson, J. F. L.; Plahte, E. (CERN, Geneva). Phys. Lett., 28B: 489-92(Jan. 20, 1969).

Explicit formulas for the N-point function in the generalized Veneziano model as an infinite sum over lower order functions are presented. The form of the amplitude exhibits clearly its physical interpretation as is believed to be useful for theoretical as well as practical applications. (auth)

15287 RISING REGGE TRAJECTORIES AND CROSSING SYMMETRY. Caser, S.; Kaplan, J. M.; Omnes, R. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Nuovo Cim., 59A: 571-8(Feb. 21, 1969).

If there are infinitely rising Regge trajectories, the asymptotic behavior of the Regge-pole terms in the s- and t-channels cannot be compatible with each other in the whole (s,t) plane. Thus the background integral cannot be neglected asymptotically if crossing symmetry is to be valid. As a consequence of this, there does not remain any restriction either on the rate of increase of possible rising Regge trajectories except possibly a lower bound in $\sqrt{s}$ or on the behavior of the residue functions. (auth)

15288 MACROSCOPIC CAUSALITY AND PERMANENCE OF SMOOTHNESS FOR TWO-PARTICLE SCATTERING. Williams, David N. (Inst. for Advanced Study, Princeton, N. J.). pp 357-76 of High Energy Physics and Fundamental Particles. Barut, Asim O.; Brittin, Wesley E. (eds.). New York, Gordon and Breach, Science Publishers, 1968.

Recent developments in the formulation of causality restrictions on the S-matrix are reviewed, with attention focused on the behavior of matrix elements of the translation operator between suitably localized in and out states. Rapid decrease for large translations outside the timelike "velocity cone" of the center of momentum follows from Poincaré invariance and boundedness of S, as a result of a generalization of a theorem of Jost and Hepp. At present, rapid decrease can be proved in the Haag-Ruelle scattering theory, when the in state is translated to large positive times, but not for the remaining timelike directions, where thresholds of intermediate particles play a role. In the case of two-particle reactions, it is shown that rapid decrease for timelike directions is equivalent to "permanence of smoothness" of the p-space wave function, as an application of rapid convergence properties of the angular momentum expansion. (auth)

15289 CHN UNIVERSALITY AND CUTS IN THE COMPLEX-l PLANE. Ne'eman, Y. (State Univ. of New York, Stony Brook. Tel Aviv Univ., Israel). pp 283-301 of High Energy Physics and Fundamental Particles. Barut, Asim O.; Brittin, Wesley E. (eds.). New York, Gordon and Breach, Science Publishers, 1968.

The CHN algebraic formulation of factorized residues is applied to inelastic processes. The result consists of (a) exact "universal" relations between forward scattering amplitudes, (b) approximate "universal" relations between differential cross sections for small non-zero values of t, assuming that the relationships between vertex-strengths persist in good approximation, and (c) nonuniversal relations between total cross sections. The effects of the CHN postulate on cuts in the complex-L plane are examined. (L.B.S.)

15290 N/D THEORY WITH SHORT-RANGE FORCES INDEPENDENT OF ANGULAR MOMENTUM. Balazs, Louis A. P. (Univ. of California, Los Angeles). pp 223-30 of High Energy Physics and Fundamental Particles. Barut, Asim O.; Brittin, Wesley E. (eds.). New York, Gordon and Breach, Science Publishers, 1968.

The determinantal approximation to the NID method is considered for strong interaction dynamical calculations. (L.B.S.)

15291 PARTIAL-WAVE SCATTERING AMPLITUDE: ZEROS, SUBTRACTIONS, AND THE SIGN OF SCATTERING LENGTHS. Kang, Kyungsik (Brown Univ., Providence). pp 231-43 of High Energy Physics and Fundamental Particles. Barut, Asim O.; Brittin, Wesley E. (eds.). New York, Gordon and Breach, Science Publishers, 1968. (NYO-2262TA-163).

The Herglotz decomposition of the partial-wave amplitude is used to study the relation between the number of zeros and the high-energy behavior of the partial-wave amplitude, the number of subtractions needed, and the behavior of the amplitude between two branch points. (L.B.S.)

15292 MULTIPARTICLE TERMS IN THE 2-BODY SCATTERING AMPLITUDE. Martinis, M. (Imperial Coll. of Science and Tech., London). Nuovo Cim., 59A: 490-518(Feb. 21, 1969).

An attempt is made to relate the Van Hove overlap-function approach with the Glauber multiparticle collision theory. It is then shown that even within strongly interacting particles at high energy and small angle the Glauber relation for the scattering amplitude holds. The derivation is based on the covariant Sudakov method for parametrizing the high-energy kinematics. On the basis of recently predicted oscillations, which seem to be connected with the particular treatment of the many-particle uni-

tarity condition, a simple phenomenological model is proposed having all the common features of other models, plus the oscillations superimposed. The numerical analysis and consequences of the model proposed are not attempted in this paper. It is also shown that the Glauber formula with the complex phase shift identified with a single Regge-pole exchange (Pomeranchukon) in the t-channel is an analytic continuation from $t > 0$ to $t \leq 0$ i.e. the s-channel) of the discontinuity $\delta_t^{(n)} f_j(t)$ of the amplitude $f_j(t)$ at the singularity $t = t_n(j)$, where $t_n(j)$ is the threshold for the creation of n Reggeons, found by Gribov et al., in their analysis of the multiparticle terms in the unitarity condition for the t-channel. The analogy is easily visualized by comparing the corresponding diagrams drawn in both approaches as well as by utilizing the simple relationship that exists between the overlap function and the Glauber complex phase shift. (auth)

15293 RELATIONSHIP OF SECOND-TYPE SINGULARITIES TO NORMAL THRESHOLDS AT THE EDGE OF THE PHYSICAL REGION. White, A. R. (Univ. of Cambridge, Eng.). Nuovo Cim., 59A: 545-70(Feb. 21, 1969).

It is shown that the discontinuity across the two-particle threshold in a subenergy variable of a two-particle–three-particle amplitude possesses a second-type singularity. This singularity has the important property of determining on which sheet of their two-particle thresholds the integrated subenergies should be taken in the integral giving the two-particle discontinuity. This singularity also has the property of complicating the sheet structure of the two-particle subenergy thresholds and the three-particle threshold in the total energy in such a way that it is not obvious that the three-particle threshold can be isolated. However, it is shown that it is possible to find a class of paths which essentially just encircle the three-particle threshold and no other singularity. It is then shown that the second-type singularity plays a vital role in the derivation of Olive's discontinuity formula for the three-particle threshold. (auth)

Particle Accelerators

15294 (BNL–13261) ANALYSIS OF IRIS-LOADED DEFLECTORS IN THE SMALL-PITCH APPROXIMATION. Hahn, H. (Brookhaven National Lab., Upton, N. Y.). Dec. 2, 1968. 33p. Dep. CFSTI.

Representation of electromagnetic waves by hybrid solutions, fields in the iris-loaded waveguide, solution for uniform–periodic structure, solution for alternating–periodic structure, accuracy of the TM_{11}-like approximation, the group velocity, standing-wave analysis, and perturbation and variational methods are discussed. (TSS)

15295 (BNL–13314) MOMENTUM COMPACTION CHANGE WITH QUADRUPOLES. Month, M. (Brookhaven National Lab., Upton, N. Y.). Jan. 16, 1969. 14p. Dep. CFSTI.

The use of point quadrupoles in order to change the momentum compaction functions was studied. Formulas for these changes are derived using first order perturbation theory. The resulting expressions are thus first order in the perturbing quadrupole strengths. An example is given and the first order theory is compared with the exact results obtained from the BEAM computer program. (auth)

15296 (BNL-13315) SHIFT OF THE ν VALUE WITH SEXTUPOLES. Month, M. (Brookhaven National Lab., Upton, N. Y.). Jan. 22, 1969. 7p. Dep. CFSTI.

The introduction of perturbing sextupoles into the AGS has the effect of producing a gradient and thus a shifting of the ν value. At any given momentum, this gradient, and the resulting shift in the ν value, are related directly to how far the sextupole centers deviate from the equilibrium orbit. An expression for this essentially momentum-independent ν shift is presented. In addition, however, sextupoles alter the relationship of ν vs p. This latter effect arises out of the fact that since the equilibrium orbit is shifted by a momentum change, the sextupole centers, if, for example, directly on the original equilibrium orbit, will deviate from the equilibrium orbit at the new momentum. Using first order (in the sextupole strengths) perturbation theory, a formula is derived for the ratio of the ν shift to the fractional change in the momentum. The case of point sextupole perturbations is treated although the formulas can be easily transformed to suit the case of a continuous sextupole distribution. (auth)

15297 (BNL-13316) EXPLANATION OF THE ν SHIFTS WITH MOMENTUM IN THE AGS. Month, M. (Brookhaven National Lab., Upton, N. Y.). Jan. 22, 1969. 10p. Dep. CFSTI.

The ν shifts with momentum as observed in the AGS (simulated by the BEAM computer program) are not the same for vertical and horizontal motion as would be expected if such ν shifts were due to the momentum dependence of the linear gradient forcing function. What is found is that, at intermediate magnetic fields, the vertical ν shift per unit fractional change in momentum is almost zero while horizontally it is found to be about –20. It is shown that this large effect, this deviation from linearity, is caused by the presence of a small sextupole term in the AGS ring magnets. Theoretical expressions for the ν shifts are obtained and comparison with the results of the BEAM program yields good agreement. (auth)

15298 (CEA-CONF–1199) THE NEW SATURNE INJECTOR: STATUS REPORT ON THE 750-keV PREINJECTOR. Faure, J. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). [1967]. 16p. (CONF-681208–2). Dep.

From Conference on Experimental Methods in Nuclear and Particle Physics, Strasbourg, France.

A status report is presented on the new 750-keV preinjector for the 20-MeV linac of the Saturne proton synchrotron. The preinjector provides a 100 mA proton pulsed beam at the linac entrance. The pulse duration is 200 μsec and the beam emittance value at the output of the preinjector itself is, so far, 2.5×10^{-6} mrd (normalized value). The preinjector is described. Emittance measurements are discussed. The ion optics between the preinjector and injector are also discussed. (B.G.D.)

15299 (CEA-CONF–1202) RAPID PULSATION OF AN ACCELERATOR BEAM BY MEANS OF A DEFLECTION BY A PROGRESSIVE WAVE. Roche, Michel. [nd]. 7p. (In French). (CONF-681208–7). Dep.

From Conference on Experimental Methods in Nuclear and Particle Physics, Strasbourg, France.

A low energy ion beam modulating device is used in an accelerator to create a pulsed neutron flux. The neutron flux is produced by interaction of the ion beam with a neutron generating target. The ion beam is deflected by a succession of short plates (2 cm). These plates, regularly spaced along the axis, are joined together by pieces of 100 Ω coaxial cable, the length of which are adjusted in such a way that the travelling wave axial velocity (i.e., the velocity of the wave measured between 2 plates) is the same as that of the beam particles. This system allowed the modulation of a deuteron beam in the energy range 150 – 400 keV in rectangular impulsions with rise times of less than 1.5×10^{-9} sec. By using a particle regrouping device in conjunction with this apparatus, neutron impulses of less than 10^{-9} sec were obtained. (auth)

15300 (CEA-CONF–1225) SOURCES OF PHOTONS OBTAINED FROM POSITRON ANNIHILATION IN FLIGHT. Audit, G.; De Botton, N.; Le Poittevin, G.; Schuhl, C.; Tamas, G. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). [nd]. 6p. (In French). (CONF-681208–3). Dep.

From Conference on Experimental Methods in Nuclear and Particle Physics, Strasbourg, France.

A calculation of the spectrum of photons obtained from positron annihilation in flight is presented. Multiple scattering and energy loss of positrons in the annihilation target are accounted for. Results are presented in the range 150–450 MeV (Saclay Linac) and compared with measurements at low energy. (auth)

15301 (CEA-CONF–1227) IONIZATION OF POLARIZED DEUTERONS IN A CYCLOTRON BY AN INTENSE ARC SOURCE. Maillard, R.; Papineau, A. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). [nd]. 3p. (In French). (CONF-681208–4). Dep.

From Conference on Experimental Methods in Nuclear and Particle Physics, Strasbourg, France.

With a large-cathode ionization source the beam of polarized deuterons now has an intensity of 5 nA. Under these conditions, the yield of polarization is estimated at 50%. (auth)

15302 (JPRS–47316) SIX BILLION ELECTRON-VOLT ELECTRON ACCELERATOR. Alikhan'yan, A. I. Translated from Priroda, 58: No. 11, 1-16(Nov. 1968). 28p. CFSTI.

Design parameters of the Yerevan 6-GeV electron synchrotron are presented, and experimental facilities and elementary particle research at the accelerator are briefly described. (W.H.K.)

15303 (PPAD–649E) ON THE USE OF NONSINUSOIDAL ACCELERATING VOLTAGES TO INCREASE THE SYNCHROTRON PHASE SPACE ACCEPTANCE. Prelec, K.; Larsen, F.; Passner, A. (Princeton-Pennsylvania Accelerator, Princeton, N. J.). Sept. 18, 1968. Contract AT(30-1)-2137. 32p. (CONF-690308–1). Dep. CFSTI.

From Particle Accelerator Conference, Washington, D. C.

A description of the synchrotron phase space acceptance is given in terms of the phase potential, and it is shown how an admixture of higher harmonics to the fundamental rf frequency

with proper amplitude-and phase-relations can give a significant gain in the captured beam. A preliminary test gave results that were in agreement with these predictions. (auth)

15304 (SLAC-Trans-89) THE MESOTRON: AN ELECTRON ACCELERATOR FOR HIGH FINAL ENERGIES. Bathow, G.; Freytag, E.; Wuester, H. O. Translated by L. B. Kapp (Stanford Linear Accelerator Center, Calif.), from report DESY-68/58. 24p. Dep. CFSTI.

The circular electron accelerator described is characterized by the following properties: the energy gain per turn is an appreciable fraction of the final energy; thus the electrons perform only a small number of turns, electrons in different turns are simultaneously accelerated in linear accelerator structures, and electrons of different energies are focussed on separated orbits; thus dc-powered magnets may be used in the circular sections. Comparison of the proposed accelerator with the conventional synchrotron and the linear accelerator is made and the possible advantages are discussed. The use of superconducting acceleration structures would allow a duty-cycle of 100%. In this case the proposed accelerator is expected to have economical advantages compared to a superconducting linear accelerator of the same duty-cycle for energies up to approx. 60 GeV. Finally, the possible application for proton acceleration is pointed out. (auth)

15305 IMPROVEMENTS IN OR RELATING TO CYCLOTRONS. (to N. V. Philips' Gloeilampenfabrieken). British Patent 1,142,623. Feb. 12, 1969. Priority date Apr. 22, 1965, Netherlands.

A cyclotron which includes at least three accelerating dee electrodes as sectors of a circle is described. (B.G.D.)

15306 NON-CLASSICAL FOCUSING DEVICES. Asner, A. (CERN, Geneva). pp 799-838 of Methods in Subnuclear Physics. Vol. 2. Nikolic, M. (ed.). New York, Gordon and Breach, Science Publishers, Inc., 1968.

Problems, concerning non classical or polychromatic focusing of charged particles, especially in connection with the generation of high intensity and high energy neutrino beams are treated. After a brief survey of the classical beam transport elements which deviate, focus, and eventually separate a monochromatic beam of a specific momentum, the possibilities of obtaining high energy neutrino beams are given. Since both the neutrino intensity and momentum are greatly dependent upon the focusing angle with respect to the detector of the neutrino parents, the charged secondary pions and kaons, a very efficient focusing system is necessary. The system should accept and sharply focus the entire momentum and angular spectrum of the neutrino parents, emitted from targets which attain lengths up to 1 m and are thus far from being a point source. The basic equations for polychromatic focusing in conical, coaxial, high current excited magnetic horns, reflectors, and in the plasma lens are given, and the advantage of cascade focusing systems are discussed. As an example, the design and layout of the new Cern neutrino beam-channel, consisting of a magnetic horn and of two reflectors are described. This new beam line, supposed to provide the most intense and the purest neutrino beam so far, has been successfully operated in 1967. The net gain in neutrino events with respect to the previous focusing system amounted to a factor of 4. Technical problems associated with the construction and operation of the complex focusing devices and the solutions adopted at CERN are also discussed and slides of the magnetic horn and the reflectors shown. (auth)

15307 THEOREM ON ION OPTICS. Blackstein, F. P. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Rev. Sci. Instrum., 40: 374-5(Feb. 1969).

In beam transport systems for high current accelerators, radiation damage of quadrupole magnets and the economics of magnet location are primary considerations. For these reasons it is desirable to place magnets at the longest possible distance from intermediate transmission targets and from one another. The following analysis provides the criterion for attaining the longest possible drift space before insertion of focusing elements in these beam lines. (B.G.D.)

15308 ANALYSIS OF COCKCROFT-WALTON VOLTAGE MULTIPLIERS WITH AN ARBITRARY NUMBER OF STAGES. Weiner, Melvin M. (American Science and Engineering, Inc., Cambridge, Mass.). Rev. Sci. Instrum., 40: 330-3(Feb. 1969).

Expressions for the direct and alternating output voltages of Cockcroft–Walton voltage multipliers with an arbitrary number of stages are determined for the joint effects of charge dissipation in the load resistance and charge storage in the diode shunt capacitances. (auth)

15309 AUTOMATIC MEASUREMENT OF EQUILIBRIUM ORBITS AT THE BROOKHAVEN AGS. Frankel, R. (Brookhaven National Lab., Upton, N. Y.). Rev. Sci. Instrum., 40: 255-7(Feb. 1969).

A method of equilibrium orbit measurement in a synchrotron which utilizes a small computer for on-line data acquisition and analysis is presented. It includes a discussion of a low cost transducer circuit which is capable of processing the high frequency, phase sensitive pulse train signals obtained from pickup electrodes located along the circumference of an alternating gradient accelerator. The analog signal thus obtained is directly suitable for use by a computer's analog/digital converter. The speed with which orbits may be measured combined with the inherent flexibility of a programable device enables accelerator physicists and machine operators to more readily probe into the behavior of the Brookhaven AGS. (auth)

15310 PARTICLE ACCELERATOR. Hall, Richard B.; Consoli, Terenzio (to Boeing Co.). U. S. Patent 3,418,206. Dec. 24, 1968. Filed Apr. 8, 1964.

A high energy particle accelerator is described which makes use of a radio frequency cavity disposed within a longitudinal magnetic field extending between opposite openings in the ends of the cavity. The magnetic field is established with a field gradient existing within the cavity being of such a magnitude that at one point in the cavity the frequency of the rf signals applied to the cavity will correspond to the cyclotron frequency of the particles for the magnetic field at that point. The magnetic field strength is established to be greater than and less than the field strength at the point at respective locations on opposite sides of that point with the arrangement being such that charged particles entering the apparatus will be highly accelerated. An improved evacuation apparatus is disclosed making use of the described particle accelerator to remove particles from a container. In a further embodiment of the invention a pair of the particle accelerators are illustrated in combination with a magnetic bottle for generating high temperatures. (U.S. Pat. Gazette)

15311 RADIOGRAPHY WITH AN ELECTRON LINEAR ACCELERATOR FOR INDUSTRY. Maekawa, Akiji (Hitachi Ltd., Tokyo); Matsuyama, Itaru. Hihakai Kensa, 17: 419-25(Oct. 1968). (In Japanese).

Inspection of pressure vessels in an atomic-power plant is indispensable in the present atomic energy age. Electron linear accelerators (or linac) are suitable for radiography of thick steel plates (200 ~ 400 mm) because of their high electron-energy and intense x-ray radiation. A linac of x-ray output 500r/min was designed especially for the industrial necessity. It is made in a compact form, is movable and has merits such as stable operation with an isolator, handy control of output power with a triode electron gun and easy change of its direction with adoption of an ion pump. Fundamental data have been obtained with this apparatus in the present study for radiography in a range from 200 to 450 mm of steel thickness, as follows: (1) Penetrameter sensitivity is about 1% for 200 ~ 450mm steel thickness. (2) The penetrameter shows a good sensitivity for film densities between 1.5 and 3.5. (3) Fluoro-metallic intensifying screens (SMP 301 and specially ordered ones) reduce the exposure time for 450 mm steel to the half of that with Pb screens. When this linac was used in the welding works, exposure time was shortened to about $1/10$ of that with a 2 MeV x-ray apparatus. (auth) (NSA of Japan)

15312 EXPERIMENTAL COMPARISON AMONG DIFFERENT TYPES OF BREMSSTRAHLUNG TARGETS FOR ELECTRONS ACCELERATED IN THE BETATRON. Isbasescu, Mircea; Panaitescu, Iulian (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys., 13: 711-21(1968).

Four target types were compared by means of measurements carried out at the 25-MeV betatron. Comparison criteria were: radiation (bremsstrahlung) intensity, energy required for ejection, focal spot size, and angular and spectral distribution of the radiation. It was established that the bent cylinder target and McMillan's target are the more suitable for radiography, whereas for physical research the pennon shaped target is the best one. (auth)

15313 SOME PROBLEMS IN APPLICATION OF ELECTRON ACCELERATOR. Inoue, Takashi; Yamauchi, Ichiro. Genshiryoku Kogyo, 14: No. 12, 33-6(Dec. 1968). (In Japanese).

The radiation chemistry, which was in a depressed condition at one time, is now again actively attacked, toward its industrial uses. Contributing to this largely is the advance in radiation generators such as industrial accelerators. In this connection, the following are described: the present state of utilization of accelerators; characteristics of a small electron accelerator, developed in Matsushita Electric Industrial Co., Ltd. (low ac-

celeration energy, large output, installation at any location, and easy operation); stability and reliability of the same accelerator; capacities of the processing; the future problems. (NSA of Japan)

15314 THE INFLUENCE OF THE LEAKAGE FACTOR ON THE DYNAMIC POLARIZATION OF PROTONS IN $(La,Nd)_2Mg_3(NO_3)_{12}.24H_2O$. Swanenburg, T. J. B.; Van Den Heuvel, G. M.; Poulis, N. J. (Kamerlingh Onnes Laboratorium, Leiden). Physica, 35: 369-85(1967).

In single crystals of $La_2Mg_3(NO_3)_{12} \cdot 24\ H_2O$ containing 0.5% to 10% Nd the proton dynamic polarization factor as well as the polarization time have been measured. The results are compared with the predictions on the basis of Borghini's spin temperature theory including the influence of the factor f. The dependence of the polarization factor and the polarization time on Nd concentration, temperature, microwave power and microwave frequency is discussed. Deviations between theory and experiment are explained by taking into account a proton relaxation mechanism due to Nd spin-spin interactions. (auth)

15315 PRODUCTION OF HIGH-ENERGY PARTICLES BY ACCELERATION OF A PLASMA SCATTERING A STRONG BEAM OF FAST ELECTRONS. Askar'yan, G. A. JETP Lett. (USSR) (Engl. Transl.), 8: 234-7(Oct. 5, 1968).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 8: 380-3(Oct. 5, 1968).

The relativistic case of the method for accelerating a plasma with a frozen-in magnetic field, scattering an electron current, to accelerate the plasma to relativistic velocities and to obtain high-energy particles is investigated. (B.G.D.)

15316 MICROTRON WITH PLASMA INJECTOR. Kreindel', Yu. E.; Ponomareva, L. P.; Shivyrtalov, M. T.; Shchanin, P. M. (Tomsk Inst. of Electronics and Electronic Tech., USSR). JETP Lett. (USSR)(Engl. Transl.), 8: 223-4(Oct. 5, 1968).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 8: 361-2(Oct. 5, 1968).

The operation of a microtron in which electrons are injected into the accelerator resonator from the plasma of a low-pressure gas discharge localized near the injection apparatus is described. (B.G.D.)

15317 CONTROLLING THE DOSE TO A SAMPLE DURING IRRADIATION WITH AN ELECTRON ACCELERATOR. Starodubtsev, S. V.; Muminov, V. A.; Generalova, V. V.; Raimbaev, S. A.; Blaunshtein, I. M. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk, No. 3-40-3 (1968). (In Russian).

The elasticity and thermal stability of polyethylene tubing are improved by radiation due to the formation of cross links between the linear molecules and an increase in the rigidity of the polymeric molecule. The elastic modulus varies inversely as the molecular weight of the structural cell. The deformation of the irradiated sample is taken as a measure of the amount of cross-linking obtained in the sample by the irradiation, and as a measure of the amount of absorbed energy. On plotting the temperature at which an irradiated sample attains a given deformation as a function of the dose on calibration curves, it is possible to obtain a satisfactory criterion for the absorbed dose. The resolution is equal to ±12% at a deformation of 1 mm. The time for carrying out a typical measurement is 14 to 16 minutes which is acceptable for an estimate of the quality of the irradiated tubing. (TTT)

15318 METHOD OF CALCULATION OF EXTERNAL STRUCTURE OF NONLAMINAR AXIALLY SYMMETRIC INTENSIVE BEAMS OF CHARGED PARTICLES WITH THERMAL VELOCITIES EQUAL TO ZERO. Kuznetsov, V. S. Zh. Tekh. Fiz., 38: 274-8(Feb. 1968). (In Russian).

An extension of a calculation method proposed in an earlier paper (ZhTF v. 37, no. 5, 1967) is presented to include the case of beams with axial symmetry, with the thermal velocities of the particles neglected. The problem of finding the charge distribution in the beam reduces to a nonstationary one-dimensional problem of determining the time dependence of the distribution function of the particles with respect to the radial coordinates and the velocities. The kinetic equation that determines the time variation of the distribution function of particles with Coulomb interaction in the absence of short-range collisions is derived directly from the Liouville theorem. When solving this equation, the latter reduces to a system analogous to the system describing the distribution function of a ribbon beam. Relations are derived for the particle trajectories which can be used to calculate the transverse velocity distribution of the particles in any cross section of a nonlaminar beam from the specified distribution function in the initial cross section. (ATD)

15319 POLARIZATION PROPERTIES OF CYCLIC ACCELERATORS. Timushev, G. F. Vestn. Mosk. Univ., Ser. III, Fiz. Astron., 23: 107-8(July-Aug. 1968). (In Russian).

Polarization properties of cyclic accelerators are studied in order to show that the particle beams accelerated in a cyclotron can be polarized even when the accelerator ion source provides non-polarized particles. A scheme is given of a cyclotron non-homogeneous field symmetric in relation to the mean plane z = 0. Particles (protons) are distributed as magnetic dipoles with counter-orientation according to the possible proton orientation spin. In such a case the dipole is subjected to the forces shifting them in a vertical direction and with a dipole momentum directed counter to the field. The forces over and under the z = 0 plane compress the dipole to the plane and the dipole with the opposite momentum is compressed by forces removed from the mean plane. Mathematical analysis of cyclotron polarization properties is given. (R.V.J.)

15320 VELOCITY DISTRIBUTION OF IONS PRODUCED BY HIGH VACUUM ION SOURCES. Zinchenko, G. N. (Inst. of Radio Physics and Electronics, Kharkov). Zh. Tekh. Fiz., 38: 1131-3(July 1968). (In Russian).

The electrons from an electron gun are accelerated by a diaphragm and move in a decelerating field between the diaphragm and the electron collector. The ions, which are produced in this section by the thermal electrons of the beam and by the secondary electrons from the collector, pass through an aperture in the collector of electrons, are additionally accelerated by a drawing electrode, and are trapped by the ion collector. The maximum spread of the ion velocity in such a system, in the case of a monotonically decreasing axial potential, is determined by the potential difference between the accelerating diaphragm and the electron collector. The experiment was performed by the retarding-potential method and electron beam current of 40 mA and an air pressure 1.2×10^{-5} mm Hg. The ion velocity distribution depended on the distribution of the potential on the path of the electron beam, on the course of the specific ionization curve, and on the value of the secondary emission coefficient of the electron collector material. Comparison of the experimental and calculated curves shows that the secondary electrons make no noticeable contribution to the ion distribution when cylindrical screens are installed between the diaphragms and the electron collector. An expression is presented for the calculation of the ion velocity distribution in ion sources with decelerating or accelerating fields. It is shown that to obtain the most uniform ion velocity distribution the electron collector material should have a low secondary emission. (ATD)

15321 MOLECULAR BEAM FOCUSING IN ELECTRIC AND MAGNETIC FIELDS WITH SPIRAL SYMMETRY. Trotsyuk, N. I. (Kiev Polytechnic Inst.). Zh. Tekh. Fiz., 38: 1140-8(July 1968). (In Russian).

Results of a theoretical investigation of the focusing of molecular and atomic beams in electric and magnetic fields of helical symmetry, having up to three symmetry and anti-symmetry lines in the cross section are presented. A series expansion of the potential of an electrostatic field with helical symmetry, in which the distribution of the potential in each plane normal to the field-producing system axis is the same and the corresponding symmetry and anti-symmetry lines are turned through an angle inversely proportional to the pitch of the helix, yields linear equations for the particle trajectories. It is shown that beams of molecules having constant negative effective electric dipole moments can be focused in electric fields with first and third helical symmetry, and beams of molecules with negative effective electric dipole moment proportional to the electric field intensity can be focused in fields with first and second symmetry. Similarly, in magnetic fields having first and third helical symmetry, it is possible to focus beams of atoms with constant negative effective magnetic dipole moment, while beams of atoms with negative effective magnetic dipole moment proportional to the magnetic field intensity can be focused in fields with first and second symmetry. Beams of atoms with negative effective magnetic dipole moment, representing an arbitrary linear function of the magnetic field intensity, can be focused in magnetic fields with first symmetry. (ATD)

15322 CHROMATIC ABERRATION OF TWO-DIMENTIONAL ELECTROSTATICAL QUADRUPOLE LENSES. Strashkevich, A. M. Zh. Tekh. Fiz., 38: 527-30(Mar. 1968). (In Russian).

It is shown that the potential of the doubly symmetrical field of symmetrical quadrupole lenses has, in the central region, symmetries with respect to the planes x = 0 and y = 0 and anti-symmetries with respect to the planes y = ±x. This property is possessed only by the near-axis region of a two-dimensional flat doubly symmetrical field; in a three-dimensional doubly

symmetrical field, on the other hand, this property does not appear. From the solution of the differential equation of the Gaussian trajectories for the central regions of two-dimensional quadrupole lenses, formulas are obtained for calculating the chromatic aberration in the plane of the Gaussian image. By integrating the Gaussian trajectories, a formula is also obtained to calculate the chromatic aberration for any plane perpendicular to the z axis. The aberration patterns in these planes are investigated. (ATD)

15323 REMOTE SYSTEMS REQUIREMENTS OF ACCELERATORS. Wilson, Mahlon T. Nucl. News, 12: No. 3, 35-7 (Mar. 1969).

The application of remote handling equipment for operation and maintenance of high-energy and high-intensity accelerators is discussed. Target and accelerator component removal systems are emphasized. (B.G.D.)

15324 POSSIBILITIES OF FORMING A COMPRESSED ELECTRON RING IN A STATIC MAGNETIC FIELD. Berg, R. E.; Kim, Hogil; Reiser, M. P.; Zorn, G. T. (Univ. of Maryland, College Park). Phys. Rev. Lett., 22: 419-21(Mar. 3, 1969).

A method of forming a compressed electron ring for an electron ring accelerator in a static rather than pulsed magnetic field is proposed. Advantages of this method as well as some problems and possible solutions are discussed and results of computer studies are presented. (auth)

15325 DISPERSION AND FOCUSING PROPERTIES OF THE HUGHES-ROJANSKY CAPACITOR FIELD BY TAKING INTO ACCOUNT SPACE CHARGE OF INVESTIGATED PARTICLES. Gamayunov, Yu. G.; Kozlov, I. G. (Saratov State Univ., USSR). Zh. Tekh. Fiz., 38: 531-8(Mar. 1968). (In Russian).

The results of a theoretical investigation of the focusing and dispersion of electrons in the electrostatic field of a Hughes-Rojansky capacitor are described with approximate allowance for the influence of the space charge of the electrons. Solution of the Poisson equation for the radial component of the field, assuming this component to be continuous on the beam boundary, yields an expression for the electric field intensity in the region occupied by the electrons. Expressions are presented for the focal strips, dispersion, and specific dispersion, with allowance for the space charge and the finite width of the beam of the charged particles at the entrance into the capacitor field at the point of the displaced focus and at an angle $\pi/\sqrt{2}$. The results show that the space charge is harmful to the focusing properties of the condenser field and shifts the position of the focus towards angles larger than $\pi/\sqrt{2}$. At the point of the displaced focus, the specific dispersion can increase with increasing space charge, but only up to a certain limit, after which a drop takes place. This growth is due to the faster increase of the dispersion due to the larger inhomogeneity of the field caused by the space charge. (ATD)

15326 STABILIZATION OF NON-RELATIVISTIC BEAMS BY MEANS OF INDUCTIVE WALLS. Neil, V. K.; Briggs, R. J. (Univ. of California, Livermore). Contract W-7405-eng-48. Plasma Phys., 9: 631-9(1967). (UCRL-70133).

A method for suppressing the negative-mass instability in beams of particles with non-relativistic velocity is proposed and investigated theoretically. The method involves surrounding the beam with an inductive wall structure incorporating lumped-circuit inductors and does not rely on a velocity spread in the beam. The condition for stability of longitudinal oscillations of a given wavelength is $v > v_p$, where v is the particle velocity and v_p is the phase velocity of a wave with the same wavelength in the same structure, but with the beam replaced by a perfect conductor. A somewhat different structure consisting of a conducting ribbon wound in a helix around the beam is also analysed semi-quantitatively and shown to be effective in suppressing the instability. (auth)

15327 ACHROMATIC SPIRAL MULTIPOLE SYSTEMS. Strashkevich, A. M.; Trotsyuk, N. I. (Kiev Polytechnic Inst.). Zh. Tekh. Fiz., 38: 520-6(Mar. 1968). (In Russian).

This is a continuation of earlier work (ZhTF v. 37, 645, 1967 and elsewhere) on electrostatic and magnetic systems with helical symmetry, whose fields have N-fold symmetry and antisymmetry in the transverse cross section. Expressions are obtained for the expansion of the potential of such fields, and formulas are obtained for the distribution of the potential for helical-symmetry electrostatic systems whose electrodes are slotted circular cylinders. A solution for the Dirichlet problem is obtained for a cylinder slotted into 2N helical ribbon parts with alternating potentials +U and –U, and also for a helical-symmetry quadrupole systems whose electrodes have hyperbolic cross sections. For the relativistic case, an equation is obtained for the near-axis trajectories of the charged particles in combined systems consisting of electrostatic and magnetic helical-symmetry systems. A general condition is obtained for the achromaticity of the trajectories in a combined multipole helical-symmetry system. As particular cases of the obtained formula, conditions are determined for the achromaticity of concrete multipole systems, whose electrodes and magnetic poles constitute slotted circular cylinders, and also for quadrupole helical-symmetry systems with hyperbolic electrode shape and hyperbolic magnetic poles. (ATD)

15328 RELAXATION AND POLARIZATION OF $La_2Mg_3(NO_3)_{12}\cdot 24H_2O$ DOPED WITH Dy^{3+}. Odehnal, M.; Loutchikov, V. I.; Ezratty, J. (Centre d'Etudes Nucleaires, Saclay, France). J. Phys. (Paris), 29: 941-52(Oct. 1968). (In French).

Details of measurements of proton relaxation time and dynamic polarization in LMN doped with Dy^{3+} are reported. The electronic relaxation time for the parallel and perpendicular orientations in the static magnetic field was measured. Data confirm that there are two doublets X and Y whose admixture by the static magnetic field is orientation dependent. Also, the nuclear relaxation time for different fields and temperatures for the two orientations was measured. Comparison with the results of various nuclear relaxation theories shows undoubtedly the importance of the $(1 - P_\theta^2)$ term. High nuclear polarization in low magnetic fields has not been achieved due to the phonon-bottleneck and the fact that the forbidden lines are not sufficiently separated from the electronic line. At high fields and with 126 kMHz irradiation, polarization as high as in LMN doped with Nd^{3+} was obtained. (auth)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 14855, 14896, 14898, 15355, 15402, 15438, 15672, 15683, 15729, 15731, and 15734.

15329 (AECL-3189) CALCULATION OF THE NEUTRON SCATTERING BY LIQUIDS AS MEASURED WITH THE COLD NEUTRON TIME-OF-FLIGHT TECHNIQUE. Cowley, R. A. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Sept. 1968. 11p. Dep. CFSTI. CAN $0.50.

Calculations are made of the neutron scattering from a liquid. The model for the liquid is to assume the scattering function, $S(Q,\omega)$, is for each wave vector Q, a Gaussian function of frequency ω centered around $\omega = 0$, with a height and width chosen so that $S(Q,\omega)$ is consistent with the measured structure factor, $S(Q)$, and the known second moment of a classical liquid. The results for the calculation of the neutron scattering obtained with the cold neutron time-of-flight technique give peaks at finite energy transfers. When the locations of these peaks are plotted as a dispersion curve in (ω,Q) space, the results are in agreement with those reported from experiments on liquids. It is concluded that the earlier interpretation of these peaks in terms of phonon-like excitations in liquids may not be correct. (auth)

15330 (BNWL-SA-1794) IMPLICATION OF RECENT FISSION AVERAGED CROSS SECTION MEASUREMENTS. McElroy, W. N. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 29, 1968. Contract AT(45-1)-1830. 20p. Dep. CFSTI.

The SAND-II code was used to study the thermal neutron-induced ^{235}U fission spectrum using a combined set of 12 activation detectors. A SAND-II representation of the fission spectrum that is only slightly different than that reported by Grundl (based on 8 activation detectors) was obtained and compared with the Cranberg analytical form (which is based on n-p scattering and time-of-flight measurements). The Grundl and SAND-II representations are in disagreement with the Cranberg, Frye, and Watt forms. These different representations were used to calculate fission-averaged cross sections for comparison with recently measured values. In order to establish consistency between the measured and calculated values, it is necessary to use the Grundl or SAND-II form of the fission spectrum in favor of the other forms. (auth)

15331 NEUTRON DOUBLE DIFFERENTIAL CROSS SECTIONS OF METHANE AND ETHYLENE. Bally, D.; Todireanu, S.; Trepadus, V.; Tarina, V. (Institutul de Fizica Atomica, Bucharest). Physica, 33: 523-7(1967).

The contribution of the spectrometer resolution to the measured value of the double differential neutron cross section of methane and ethylene for $E = E_0$ was studied. A good agreement was obtained between the experimental value $\sigma(E_0,E_0,\Phi)$ for $E_0 = 25$ MeV and $\Phi = 16.3°$ and that given by Griffing. The following problems were discussed: the calibration of measured cross section and the corrections for multiple scattering and second-order reflections. (auth)

15332 A NUMERICAL INTEGRATION METHOD IN THE P_n APPROXIMATION. Pavelescu, M. (Inst. of Atomic Physics, Bucharest); Saveanu, L. Rev. Roum. Phys., 13: 661-71(1968).

A numerical calculational method is proposed for the P_3 approximation. Owing to the form of the equations in the P_n approximation, which is similar to that of the equations in multigroup diffusion approximation, the numerical techniques used in the multigroup diffusion approximation are extended to the P_n approximation and are used to obtain a matrix form which can be used on electronic computers. (auth)

15333 THE EXISTENCE OF A DISCRETE DECAY CONSTANT EXCEEDING $(v\Sigma(E))_{min}$ IN THE PULSED NEUTRON EXPERIMENT. Wood, J. (Queen Mary Coll., London). J. Phys., D (London), 2: 149-58(Feb. 1969).

The Boltzmann transport equation for a pulsed source of neutrons in a nonmultiplying medium is investigated by means of the ansatz $\phi(E,\Omega)\exp(iB\cdot r - \lambda t)$. The resulting eigenvalue equation for λ is considered in the multigroup approximation. The existence of a discrete decay parameter exceeding $(v\Sigma(E))_{min}$, identifiable as the "continuation" of the fundamental time eigenvalue λ_0, is demonstrated. A rapidly converging iterative scheme for computing the eigenvalues greater or less than $(v\Sigma(E))_{min}$ is described. The calculated and experimental values of λ_0 are compared for various polycrystalline moderators over a wide range of buckling. The analytic continuation of the dispersion law and the variation of λ_1 with buckling are also demonstrated. (auth) (UK)

15334 TIME-DEPENDENT SUSCEPTIBILITY AND NEUTRON SCATTERING CROSS SECTION OF THE ISING MODEL WITH GENERAL SPIN. Essam, J. W.; Garelick, H. (London Univ.). J. Phys., C (London), 2: 317-29(Feb. 1969).

A sum-rule method is used to determine the response of an Ising ferromagnet to a time-dependent transverse magnetic field. A similar method yields the energy distribution of the inelastic neutron scattering cross section. The results are valid for arbitrary temperature including the critical region, and the effect of a static parallel magnetic field of finite magnitude is also considered. (auth) (UK)

15335 ANOMALOUS CAPTURE OF THERMAL POLARIZED NEUTRONS IN PERFECT FERROMAGNETIC SINGLE CRYSTALS. Michalec, R. (Nuclear Research Inst., Prague); Stich, V. Czech. J. Phys., 19: 278-80(1969).

It is shown that the interaction of the magnetic moment of neutrons with the magnetic moments of atoms bound in a perfect ferromagnetic single crystal may result in the anomalous capture of thermal polarized neutrons. (J.W.R.)

15336 NEW MODEL FOR THE CALCULATION OF NEUTRON SCATTERING. Richter, J.; Voss, K. (Technische Univ., Dresden). Phys. Lett., 28A: 376-7(Dec. 16, 1968).

The linearized Vlasov–Boltzmann equation is used as a model for the calculation of thermal neutron scattering in liquid argon. The variation of the width of the quasi-elastic peak is obtained without use of the convolution approximation. (auth)

15337 TEMPERATURE DEPENDENCE OF THE CURIE POINT FOR IRON OBSERVED IN THE CRITICAL SCATTERING OF NEUTRONS. Blinowski, K. (Inst. of Nuclear Research, Swierk, Poland); Ciszewski, R. Phys. Lett., 28A: 389-90 (Dec. 16, 1968).

The small-angle critical scattering of neutrons in iron was measured. The temperature shift of a maximum of scattered intensity has been discussed in the light of the latest theories. (auth)

15338 EFFECTIVE SOLUTION TO THE INITIAL VALUE PROBLEM IN NEUTRON THERMALIZATION THEORY. Mika, J. (Inst. of Nuclear Research, Swierk, Poland); Stankiewicz, R.; Trombetti, T. J. Math. Anal. Appl., 25: 149-61(Jan. 1969).

An effective solution to the initial value problem in neutron thermalization is presented assuming isotropic scattering. The geometries considered are an infinite slab and a bounded convex body. (D.C.W.)

15339 SPECTRUM OF RELAXATION LENGTHS OF NEUTRON DISTRIBUTIONS IN A MODERATOR. Kuscer, I.; Vidav, I. (Univ. of Ljubljana, Yugoslavia). J. Math. Anal. Appl., 25: 80-92(Jan. 1969).

The transport equation for neutrons in a uniform sourceless medium may have solutions proportional to e^{-kx}, where k is the reciprocal of one of the so-called relaxation lengths. The spectrum of the reciprocal relaxation lengths for a neutron gas in a uniform moderator is studied in detail. (D.C.W.)

15340 MAGNETIC NEUTRON SCATTERING IN THIN FILMS. Wojtczak, Leszek (Univ. of Lodz, Poland). Rev. Roum. Phys., 13: 637-40(1968).

The properties of the magnetic neutron scattering in thin films are discussed. The discrete spectrum of scattering angles is obtained. There exists a relation between the spectrum obtained and the spin-wave frequencies. (auth)

15341 SPIN-WAVE THEORY OF IMPURITY STATES IN A HEISENBERG ANTIFERROMAGNET. II. NEGATIVE IMPURITY-HOST EXCHANGE COUPLING. Lovesey, S. W. (Oxford Univ.). J. Phys., C (London), 1: 118-24(Feb. 1968).

In the previous paper the energy modes of a magnetic impurity with positive impurity-host exchange in an antiferromagnet were discussed. The appropriate thermal two-time Green functions were derived, from which both the impurity states and inelastic neutron cross section were calculated. In this paper essentially the same scheme is followed to discuss the case of a negative impurity-host exchange coupling. The p-, d- and f-type modes remain the same, but only one s-like mode occurs as opposed to two in the previous case. The energies and widths of this s mode are given for a wide range of the perturbation parameters. The diffuse inelastic neutron cross section is also calculated.

This has exactly the same form as for an antiferromagnetic impurity in a ferromagnet, but does not show the same energy behavior because of the difference in the spin-wave spectra of the ferromagnetic and antiferromagnetic hosts. (auth) (UK)

15342 END EFFECT IN A HOLLOW CYLINDER RESONANCE FILTER. Damburg, N. A.; Pelekis, L. L. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser., No. 6, 34-6(1968). (In Russian).

The end effect in a cadmium filter for reactor neutrons was measured. The filter has a form of a hollow cylinder with open end. The end effect is characterized by the depth of thermal neutrons penetration through the open end of the filter. The thermal neutron flux distribution along the filter height of two cylinder diameters: 30 mm and 50 mm is presented. The neutron flux has been found to decrease to 2% at the depth equivalent to approximately two diameters of the filter. (auth)

15343 THE MEASUREMENT OF EXTRAPOLATION DISTANCES IN PULSED BeO ASSEMBLIES. Ritchie, A. I. M. (Australian Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). J. Nucl. Energy, 22: 717-34(Dec. 1968).

The time-dependent spatial flux distributions in five BeO assemblies covering the buckling range 0.9×10^{-2} to 2.15×10^{-2} cm^{-2} were measured. "Waiting times" of at least 2.5 msec were used in all cases. The extrapolation distance derived from the flux distribution decreases with increasing buckling and is between 20 and 50% higher than the value 0.71 λ_{tr} at zero buckling. A simple model, used to approximate the transport cross section of BeO, shows that these experimental results are not in agreement with theoretical predictions. Qualitative arguments are advanced to explain this lack of agreement. A correlation is noted between the behavior of the decay constants of the higher spatial modes in the two assemblies of largest buckling with the behavior of the decay constant of the fundamental in assemblies with buckling greater than Corngold's value for B_3^2. (auth)

15344 EXPERIMENTAL AND CALCULATED ENERGY SPECTRA OF Am–Be AND Pu–Be NEUTRON SOURCES. Notarrigo, S.; Porto, F.; Rubbino, A.; Sambataro, S. (Univ., Catania, Italy). Nucl. Phys., A125: 28-32(1969).

The Am–Be neutron spectrum was measured and was also calculated taking into account the anisotropy in the angular distribution of neutrons from the $^9Be(\alpha,n)$ reaction. Very good agreement was found between the measured and calculated spectra. Experimental data and calculated spectra for Pu–Be sources were also compared. (auth)

15345 SOME CHARACTERISTICS OF THE NEUTRON GENERATOR. I. THE MEASUREMENT OF $^3H(d,n)^4He$ REACTION NEUTRON FLUX BY AN ACTIVATION METHOD. Kawakami, Hiroyasu; Oda, Toshiyuki (Kyushu Univ., Japan). Onken Kiyo, 20: 166-71(June 1968). (In Japanese).

The 14.1-MeV monoenergetic neutron flux, which was obtained by $^3H(d,n)^4He$ reactions in Hitachi NG-200-2 Type Neutron Generator, was measured by an activation method using the $^{32}S(n,p)^{32}P$ reaction. The isotope ^{34}S, which was used as a detector material, was reduced to the radioisotope ^{31}Si by a competing reaction $^{34}S(n,\alpha)^{31}Si$; therefore it was necessary to have an adequate cooling time before measuring the activity of the radioactive material which was produced by neutron irradiation. The difference among the values of relative neutron flux measurements were less than ±10%. The value of the neutron flux in the vertical direction toward a target face was about 20% higher than the horizontal flux. (NSA of Japan)

Nuclear Properties and Reactions, A≤ 5

Refer also to abstracts 14103, 14474, 15500, 15505, and 15507.

15346 (ORO–1316-70) PROGRESS REPORT [ON NUCLEAR PHYSICS], TASK A. (Rice Univ., Houston, Tex.). 1968. Contract AT(40-1)-1316. 21p. Dep. CFSTI.

Developments in the neutron physics program, three-body breakup reaction studies, charged-particle reaction studies, polarization studies using polarized ^3He targets, nuclear theory, and instrumentation are reported. (D.C.W.)

15347 STUDY OF $^3He + ^4He$ AND $^3H + ^4He$ SYSTEMS WITH THE RESONATING-GROUP METHOD. Brown, Ronald E.; Tang, Y. C. (Univ. of Minnesota, Minneapolis). Phys. Rev., 176: 1235-45(Dec. 20, 1968).

The resonating-group method, which employs a completely antisymmetric wave function, was used to consider the problem of elastic scattering of ^3He and ^3H by ^4He. The nucleon-nucleon potential used in the calculation is purely central, but fits the low-energy scattering data satisfactorily. The calculated phase shifts are compared with those which have been obtained from an analysis of experimental data, and rather good agreement is found. In particular, the calculated l = 3 phase shift for both systems exhibits a resonance behavior which indicates the presence of a ^2F level lying between the $^2F_{\frac{5}{2}}$ and $^2F_{\frac{7}{2}}$ levels found experimentally. Effective, local, l-dependent potentials between the ^4He cluster and the ^3He or ^3H cluster were also derived. They are approximately energy-independent and contain features which have been found in phenomenological analyses of elastic scattering in light systems. Effects due to specific distortion of the ^3He or ^3H cluster were also examined in an approximate fashion. Here it is found that the effects on the ^2F excitation energy and on the nonresonant phase shifts are only of minor importance. (auth)

15348 LOWER ESTIMATE FOR ENERGY OF A SYSTEM OF INTERACTING PARTICLES IN FRAMEWORK OF THE SCHROEDINGER EQUATION. Savchenko, O. Ya. (Inst. of Nuclear Physics, Novosibirsk, USSR). Yadern. Fiz., 8: 1259-63(Dec. 1968). (In Russian).

A variational approach is applied to determine the lower bound of the total energy of a system of interacting particles in framework of the Schroedinger equation. This approach is used to obtain an approximate lower bound for the ground-state energies of the nuclei T and ^4He. (auth)

15349 LOW-ENERGY PROPERTIES OF REALISTIC N–N ONE-BOSON-EXCHANGE POTENTIALS. Gersten, Alexander; Green, A. E. S. (Univ. of Florida, Gainesville). Phys. Rev., 176: 1199-1204(Dec. 20, 1968).

The low-energy features of the N–N interaction, as described by three realistic one-boson-exchange potential models, were examined. These models are the Green–Sawada two-parameter model, the Bryan–Scott III model, and the Ueda–Green I model. The deuteron binding energy, wave functions, magnetic and quadrupole moments, effective range, and electromagnetic form factors were calculated. Where possible, these quantities were compared with the experimental data. (auth)

15350 SEARCH FOR STATES IN THE THREE-NEUTRON AND TRITON SYSTEMS. Ohlsen, Gerald G.; Stokes, Richard H.; Young, P. G. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 176: 1163-5(Dec. 20, 1968).

Spectra of ^3He from the bombardment of tritium and of ^3He targets with 22.25-MeV tritons are presented. No clear evidence for new states in either residual nucleus was obtained; however, the $^3H(t,^3He)3n$ spectra provide weak evidence for the existence of a "trineutron" unbound by 1 to 1.5 MeV. (auth)

15351 REACTION $T(^3He,\gamma)^6Li$ IN THE ENERGY RANGE 0.5 TO 11 MeV. Blatt, S. L.; Young, A. M.; Ling, S. C.; Moon, K. J.; Porterfield, C. D. (Ohio State Univ., Columbus). Phys. Rev., 176: 1147-53(Dec. 20, 1968).

Gamma spectra from the radiative capture of ^3He particles by tritons were obtained over the energy range $0.5 \leq E(^3He) \leq 11.0$ MeV. Strong transitions were seen to the ground and first two excited states of ^6Li; excitation curves and angular distributions are presented. The integrated cross section for the inverse reaction $^6Li(\gamma_0,t)^3He$ up to $E_\gamma = 25$ MeV is found to be 9.3 ± 1.4 MeV mb. Evidence is also found for a transition to the second T = 1 state of ^6Li. The results are discussed in the framework of the direct-capture model. Substantial $T + ^3He$ clustering is evident in the four observed ^6Li final states. (auth)

15352 BARYON RESONANCES IN NUCLEI: MAGNETIC MOMENT ANOMALY IN ^3H AND ^3He. Arenhoevel, H.; Danos, M. (National Bureau of Standards, Washington, D. C.). Phys. Lett., 28B: 299-301(Dec. 23, 1968).

The exchange current contributions to the static magnetic moments of ^3H and ^3He are described by the admixture of baryon resonances to the ground state. It is found that the dominant contribution comes from the admixture of the $N^*(1470)$ in a spatial symmetric $^2S_{\frac{1}{2}}$ state by means of the magnetic photoproduction matrix element. An admixture of about 1 percent would be sufficient to account for the magnetic moment anomaly. (auth)

15353 SEPARABLE REPRESENTATION OF THE TWO-PARTICLE t-MATRIX AND THE THREE-NUCLEON PROBLEM. Sitenko, A. G.; Kharchenko, V. F.; Petrov, N. M. (Inst. of Physics, Kiev). Phys. Lett., 28B: 308-12(Dec. 23, 1968).

On the basis of the Faddeev equations the triton binding energy and the neutron–deuteron scattering lengths are calculated using

the separable representation of the two-nucleon t-matrices in case of the local Hulthèn potential. (auth)

15354 CORRELATIONS IN ^{4}He FROM ELASTIC ELECTRON SCATTERING. Stovall, T.; Vinciguerra, D. (Ecole Normale Superieure, Orsay, France). Nuovo Cim., Lett., 1: 100-2(Jan. 11, 1969).

The effects of higher-order correlations on the elastic form factor of ^{4}He were investigated. The proton distribution and the form factor were calculated using a Jastrow-type wave function to include nucleon correlations. It was shown that a small hard-core radius can give rise to effects in the wave function out to relatively large distances. (D.C.W.)

15355 POLARIZATION OF NEUTRONS FROM THE D–D REACTION. Drigo, L.; Manduchi, C.; Moschini, G.; Manduchi, M. T. Russo; Tornielli, G.; Zannoni, G. (Univ., Padua). Nuovo Cim., Lett., 1: 237-41(Feb. 1, 1969).

The polarization of neutrons from the D–D reaction at deuteron energies of 1.1 to 3.1 MeV was investigated in order to determine the coefficients in a series expansion of the differential polarization. The polarization of the neutrons was determined by measuring the left-right asymmetry from a helium polarimeter. (D.C.W.)

15356 ANALYSIS OF NUCLEAR SCATTERING BY REGGE POLES. Shanta, R.; Shastry, C. S. (Saha Inst. of Nuclear Physics, Calcutta). Phys. Rev., 176: 1254-67(Dec. 20, 1968).

The validity and usefulness of the complex angular-momentum formulation in nuclear scattering are investigated by studying the elastic scattering of α particles by ^{4}He, ^{12}C, and ^{16}O in terms of the Regge trajectories through suitable Regge-type representations for the S-matrix. The trajectories are obtained from the resonant levels of the compound nuclei, and residues are calculated by imposing unitarity on the Regge-type representations for the S-matrix. The differential cross sections obtained by this method are compared with those obtained by experiment and by the Ackhiezer–Pomeranchuk–Blair–McIntyre model with resonant phase shifts. In order to establish the merit of the Regge-pole approach, cross sections are calculated in terms of the poles of the S-matrix in the momentum plane and compared with the results obtained by using the complex angular-momentum formulation. These studies provide an interesting method for the analysis of nuclear scattering. (auth)

Nuclear Properties and Reactions, $6 \leq A \leq 19$

Refer also to abstracts 14637, 15346, 15356, 15402, 15502, 15507, 15512, 15515, 15519, and 15526.

15357 LIFETIMES OF LEVELS IN A = 10 NUCLEI. Fisher, T. R.; Hanna, S. S.; Healey, D. C.; Paul, P. (Stanford Univ., Calif.). Phys. Rev., 176: 1130-9(Dec. 20, 1968).

The Doppler-shift attenuation method was used to obtain the following mean lifetimes (in psec) for the indicated nuclear levels: ^{10}C(3.36), $\tau = 0.155 \pm 0.025$; ^{10}B(3.59), $\tau = 0.150 \pm 0.015$; ^{10}Be(3.37), $\tau = 0.189 \pm 0.020$; ^{10}B(2.15), $\tau = 2.7$. A limit of $\tau < 30$ fsec is obtained for ^{10}B(1.74), which is a factor of 8 greater than, and therefore consistent with, the lifetime computed from the analog β decay of ^{10}C. Transition strengths obtained from the ^{10}B(2.15) and ^{10}B(3.59) lifetimes are in good agreement with the effective-interaction calculations of Cohen and Kurath, as modified by Warburton et al. The ^{10}C(3.36) and ^{10}Be(3.37) states decay by analog E2 transitions: 2^+, $T = 1 \rightarrow 0^+$, $T = 1$, with $T_z = \pm 1$, whose strengths are well described by calculations of Kurath's for an effective charge $\epsilon_n = \epsilon_n = 0.5$. An upper limit was obtained for the corresponding transition $5.17 \rightarrow 1.74$ in ^{10}B($T_z = 0$) which is consistent (factor of 4 greater) with the analog strengths observed in the $T_z = \pm 1$ nuclei. (auth)

15358 OBSERVATION OF THE LOWEST p-SHELL T = 3/2 STATES OF ^{11}B AND ^{11}C. Cosper, S. W.; McGrath, Robert L.; Cerny, Joseph; Maples, Creve C.; Goth, George W.; Fleming, Donald G. (Univ. of California, Berkeley). Phys. Rev., 176: 1113-19(Dec. 20, 1968).

The ^{11}B and ^{11}C T = 3/2 analogs of the ^{11}Be(0.32-MeV) state were located utilizing the ^{12}C(p,^{3}He)^{11}B and ^{12}C(p,t)^{11}C reactions. The new states lie at 12.94 ± 0.05 MeV in ^{11}B and at 12.47 ± 0.06 MeV in ^{11}C, and have total widths of 350 ± 50 and 550 ± 50 keV, respectively; their spins and parities were found to be $\frac{1}{2}^-$. A check on their isospin purity was achieved by examination of their charged-particle decay properties; it was found that the major decay mode is via L = 1 isospin-allowed proton emission. (auth)

15359 GAMMA DECAYS FROM THE FIRST T = 3/2 LEVELS IN ^{13}N AND ^{13}C. Cocke, C. L.; Adloff, J. C.; Chevallier, P. (Institut de Recherches Nucleaires, Strasbourg). Phys. Rev., 176: 1120-5(Dec. 20, 1968).

The reactions ^{11}B(^{3}He,n)^{13}N* (T = 3/2) (γ) and ^{11}B(^{3}He,p)^{13}C* (T = 3/2) (γ) were used to study the γ-decay modes of the lowest T = 3/2 states in ^{13}N and ^{13}C. Coincidences between neutrons and associated γ rays in the case of ^{13}N and between protons and γ rays in the case of ^{13}C were recorded in a two-dimensional array. For the γ decay of ^{13}N(15.07) and ^{13}C(15.11), the ratios $\Gamma_{\gamma 0}/\Gamma_{p 0} = (12 \pm 2)\%$ and $\Gamma_{\gamma 0}/\Gamma = (0.53 \pm 0.06)\%$ were obtained, respectively. When combined with previously available experimental information, these values yield $\Gamma = 1.13 \pm 0.3$ and 4.7 ± 1.6 keV for the first T = 3/2 levels in ^{13}N and ^{13}C, respectively. Additional information on γ branching ratios and particle decay for these levels is presented. (auth)

15360 SEARCH FOR UNBOUND STATES IN ^{3}He THROUGH ^{6}Li(p,α). Olsen, David K.; Brown, Ronald E. (Univ. of Minnesota, Minneapolis). Phys. Rev., 176: 1192-8(Dec. 20, 1968).

The shape of the α-particle continuum from the ^{6}Li(p,α) reaction at a proton energy of 20.0 MeV (lab) was investigated for structure due to excited states of ^{3}He. Alpha spectra were measured with thin surface-barrier detectors from 15° to 85° (lab) in steps of 5°. The maximum ^{3}He excitation energy which could have been observed with this experimental technique depended upon the lab angle and varied from 14.3 to 10.1 MeV. In order to continuously monitor the target composition, protons elastically scattered at 90° (lab) were observed simultaneously with the α-particle spectra. No clear structure attributable to the formation of excited states of ^{3}He was observed. In particular, an upper limit of 300 μb/sr (lab) can be placed on the differential cross section at 20° (lab) for the excitation of a 12-MeV state in ^{3}He having a natural width of 0.9 MeV (c.m.). (auth)

15361 ^{12}C(γ,p)^{11}B ANGULAR DISTRIBUTIONS IN AND JUST ABOVE THE GIANT RESONANCE. Frederick, David E.; Sherick, A. Daniel (Ames Lab., Iowa). Phys. Rev., 176: 1177-91(Dec. 20, 1968).

The energy and angular distributions of photoprotons were observed with 30.5- and 32.1-MeV electron bremsstrahlung using the $\Delta E \times E$ coincidence technique. The angular-distribution anisotropy parameter A_2 has the average value -0.56 in the giant resonance peak from 21.8 to 23.7 MeV and varies less than ±0.05 from that value. From 24.4 to 28 MeV, variations in A_2 of about ±0.2 were detected and correlate somewhat with bumps seen in the total cross section. Above 28 MeV, A_2 decreases toward -0.9. No model yet exists which predicts correctly the anisotropy observed about the giant resonance. The probable nature of the particle-hole states at and above 25 MeV is deduced. The asymmetry parameters A_1 and A_3 are everywhere nonzero, have opposite signs, and exceed 0.3 in magnitude above 29 MeV, indicating moderate electric-dipole–quadrupole interference. This is interpreted as being consistent with one particle–one hole quadrupole excitation of $\lesssim 1\%$ relative to the dipole photoproton emission strength. (auth)

15362 ALPHA-PARTICLE YIELDS AND ANGULAR DISTRIBUTIONS IN THE ^{16}O(^{6}Li,α_0)^{18}F REACTION FROM 4.8 TO 13.8 MeV. Greene, M. Wayne (Dept. of Physics and Astronomy, Iowa City, Iowa). Phys. Rev., 176: 1204-8(Dec. 20, 1968).

The yield and angular distributions of α particles from the ^{16}O(^{6}Li,α_0)^{18}F reaction were measured for the bombarding range 4.8 to 13.8 MeV. Nine distinct peaks were observed in the yield curve measured at 0° and had peak-to-valley ratios varying from 1.3 to 6.0. A fluctuation analysis of the yield curve gives a corrected coherence width $\Gamma = 0.49 \pm 0.40$ MeV (c.m. system) in the excitation energy range of ^{22}Na of 18.0 to 24.6 MeV for the sample size n = 5.3. This analysis predicts a direct reaction contribution to the differential cross section of 0 to 60%. Angular distributions were measured at seven energies: 5.50, 5.70, 6.22, 11.60, 12.20, 12.80, and 13.30 MeV, which correspond to peak and valley energies observed in the yield curve. At the three lowest bombarding energies, the angular distributions have little structure, while at the four higher energies they oscillate rapidly. (auth)

15363 NONEXISTENCE OF THE 14.6-MeV STATE IN ^{7}Be. Parker, P. D.; Mingay, D. W.; Overley, J. C. (Yale Univ., New Haven). Phys. Rev., 176: 1211-12(Dec. 20, 1968).

A level was previously reported at an excitation energy of 14.6 MeV in ^{7}Be from a study of the ^{10}B(p,α)^{7}Be reaction using range techniques. This reaction was reexamined using energy-sensitive detectors, and the α particles previously attributed to this level were identified, instead, as recoiling ^{7}Be ions and as α particles from the breakup of recoiling ^{8}Be nuclei. (auth)

15364 COUPLED-CHANNEL CALCULATION OF ^{12}C NEUTRON SCATTERING. Reynolds, J. T.; Slavik, C. J.; Lubitz,

C. R.; Francis, N. C. (Knolls Atomic Power Lab., Schenectady, N. Y.). Phys. Rev., 176: 1213-26(Dec. 20, 1968).

Coupled-channel calculations are described for the interaction between a neutron and ^{12}C. Emphasis is placed on the incident-energy region between 0 and 5 MeV, although the bound states are also calculated. Precise fits to total, elastic differential, and polarization cross sections are obtained. Comparisons with other treatments of the A = 13 system are made, and the differences are discussed, in particular the meaning of the weak-coupling approximation. Deficiencies in the present method of calculation are also discussed. (auth)

15365 $^{6}Li(p,p')^{6}Li(3.56\ MeV)$ REACTION FROM E_p = 24.3 TO 46.4 MeV AND THE EFFECTIVE INTERACTION. Austin, S. M.; Locard, P. J.; Benenson, W.; Crawley, G. M. (Michigan State Univ., East Lansing). Phys. Rev., 176: 1227-32(Dec. 20, 1968).

The total cross section for the $^{6}Li(p,p')^{6}Li(3.56\ MeV)$ reaction was measured by observing the isotropic 3.56-MeV de-excitation γ rays in a 20-cm^3 Ge(Li) detector and was found to decrease slowly with energy. In a microscopic model of the reaction, this cross section depends only on the spin-isospin–dependent part V_{11} of the effective interaction. At energies above 34 MeV, the data are well described by a potential, $V_{11} = Ve^{-\alpha r}/\alpha r$, where the range $1/\alpha$ is taken to be 1.0 F, and V = 12.1 MeV. At 25 MeV, V = 11.1 Mev fits the data. The impulse approximation predicts a cross section larger than the data for the energy range of this experiment, the ratio decreasing from 2.9 at 25 MeV to 1.4 at 45 MeV. Available evidence on the spin-isospin–dependent interaction is summarized. For proton energies between 23 and 52 MeV, the strength of V_{11} lies in the range 12.5 ± 2.5 MeV and does not appear to vary with energy. (auth)

15366 $^{9}Be(p,p\alpha)^{5}He$ REACTION AT 57 MeV. Roos, P. G. (Univ. of Maryland, College Park); Pugh, H. G.; Jain, Mahavir; Holmgren, H. D.; Epstein, Martin; Ludemann, C. A. Phys. Rev., 176: 1246-53(Dec. 20, 1968).

The $^{9}Be(p,p\alpha)^{5}He$ reaction was studied using 57-MeV protons from the Oak Ridge isochronous cyclotron. The correlated energies of both the emitted protons and α particles were measured at detection angles (θ_p,θ_α) of (94°, –35.3°), (105°, –30°), and (116°, –25.1°), where the detectors were coplanar with the beam. In addition, an angular correlation was measured by fixing θ_p at 105° and varying θ_α from –21° to –39° in 3° steps. The data for the reaction leading to the ground state of ^{5}He were found to be consistent with quasifree scattering of the incident protons by S-state α-particle clusters in ^{9}Be. Analysis in terms of a plane-wave impulse approximation yields a momentum density distribution for the struck α particles which has a half-width of 0.27 F^{-1}, and a probability of finding an α-particle cluster in ^{9}Be of 0.25. (auth)

15367 HIGH-RESOLUTION STUDY OF ISOBARIC ANALOG RESONANCES IN ^{23}Na. Keyworth, G. A.; Wilhjelm, P.; Kyker, G. C. Jr.; Newson, H. W.; Bilpuch, E. G. (Duke Univ., Durham, N. C.). Phys. Rev., 176: 1302-10(Dec. 20, 1968).

Excitation functions for the elastic scattering of protons by ^{22}Ne were measured at 90, 105, 120, 135, 150, and 160° from 0.8 to 3.13 MeV, and for the reaction $^{22}Ne(p,p')^{22}Ne^*$ (first excited state), at 90, 120, and 150° from 2.0 to 3.13 MeV, with an average energy resolution of about 250 eV. Spins, parities, and partial and total widths were extracted for the large majority of the 76 resonances observed. Two isobaric analog states, those of the sixth and seventh excited states of ^{23}Ne, were identified. Both analogs are evidenced as fragmentations of the broad $T_>$ states into enhancement of the background $T_<$ states. A sum rule applied to the individual fine-structure widths implies spectroscopic factors in agreement with those extracted from (d,p) stripping measurements on ^{22}Ne. (auth)

15368 STUDY OF THE REACTION $p + {}^{11}B \rightarrow 3\alpha$ AT 1.4 MeV BY THE METHOD OF COINCIDENCES. Laugier, J. P.; Cadeau, M.; Mouilhayrat, G.; Marquez, L. J. Phys. (Paris), 29: 829-38 (Oct. 1968). (In French).

Several coincidence spectra coming from the sequential reaction $p + {}^{11}B \rightarrow {}^{12}C^* \rightarrow \alpha + {}^{8}Be^*$, $^{8}Be^* \rightarrow \alpha + \alpha$ at 1.4 MeV were measured. These spectra can be explained quantitatively with a constant width of $^{8}Be^*$ if an interference term is introduced. The events in which an α particle has zero energy are forbidden. (auth)

15369 TEST OF THE CLUSTER-KNOCKOUT MODEL USING THE REACTION $^{6}Li(p,p\alpha)d$. Roos, P. G.; Him, Hogil; Jain, Mahavir; Holmgren, H. D. (Univ. of Maryland, College Park). Phys. Rev. Lett., 22: 242-5(Feb. 10, 1969).

The reaction $^{6}Li(p,p\alpha)d$ was studied as a function of angle at 6.15 MeV. The cross section was measured for ten proton angles. Using the quasifree knockout approximation, the $^{6}Li(p,p\alpha)d$ angular distribution was compared with the free $p-\alpha$ elastic scattering angular distribution. The agreement between the two is extremely good. (auth)

15370 THE POLARIZATION OF THE NEUTRONS FROM THE REACTION $^{13}C(\alpha,n)^{16}O$. Schoelermann, H. (Univ., Hamburg). Z. Phys., 220: 211-17(1969). (In German).

The angular distribution of the polarization of neutrons from the reaction $^{13}C(\alpha,n)^{16}O$ was determined between 1.38- and 2.26-MeV energy of the α particles by left-right asymmetry induced by elastic scattering from ^{4}He. The neutrons were detected by a time-of-flight method between a helium gas scintillation counter and two plastic scintillation counters. From Simon and Welton theory analysis, a set of spectroscopic data was obtained for seven states of the compound nucleus ^{17}O. (auth)

15371 QUASIMOLECULAR STATES IN THE INTERACTION BETWEEN ^{12}C AND ^{12}C NUCLEI. Imanishi, B. (Nihon Univ., Tokyo). Nucl. Phys., A125: 33-56(1969).

The resonances observed in the reactions of ^{12}C on ^{12}C at the energies just about the Coulomb barrier are investigated by assuming the molecule-like compound state formed by the two carbon nuclei, one in the ground state and another in the first excited state. These compound states are assumed to be coupled to the incident channel only and a resonance formula for the amplitude of the elastic scattering is derived. The interaction potential between two carbon nuclei is that obtained by introducing the effects of deformation and a repulsive core into spherical optical potential. The depth of the potential is taken to be rather shallow (≈–20 MeV). The numerical calculations show that the energies of the compound state are approximately reproduced with the rotational deformation parameter of $\beta \approx -0.2$. The calculated resonance energies are slightly shifted from the level energies of the compound states, and the reasonable carbon widths are obtained. (auth)

15372 VECTOR ANALYZING POWER IN (d,p) REACTIONS AND THE WBP MODEL. Pearson, C. A.; Wilcott, J. C.; McIntyre, L. C. (Univ. of Arizona, Tucson). Nucl. Phys., A125: 111-28(1969).

Calculations for vector analyzing power P_D with the weakly bound projectile model are compared with measured values for (d,p) reactions on ^{12}C, ^{24}Mg, ^{40}Ca, and ^{52}Cr. All the available measurements for P_D are reproduced, as well as measurements for the proton polarization P_y in reactions with unpolarized deuterons, and the j_n dependence of differential cross sections. (auth)

15373 WAVE FUNCTIONS IN 1p-SHELL NUCLEI. Varma, S.; Goldhammer, Paul (Univ. of Kansas, Lawrence). Nucl. Phys., A125: 193-204(1969).

Static magnetic moments, M1 transition rates, spectroscopic factors for (d,p), (p,^{3}He) and (p,^{3}H) reactions and Gamow-Teller transitions were calculated for 1p-shell nuclei using wave functions derived by Goldhammer, Hill, and Nachamkin. Results were compared with experiment and with the shell-model calculations of Cohen and Kurath. The general trend of agreement was found to be consistent with a gradual increase in configuration mixing throughout the shell. It was found that this mixing implies a channel coupling of $^{3}S_1$ and $^{3}D_1$ partial waves beyond the 1p shell, whose magnitude is approximately 9% in ^{6}Li and 20% in ^{14}N. (auth)

15374 APPLICATION OF THE THEORY OF COMPLEX ENERGY RESONANCES TO THE STUDY OF THE REACTION $^{6}Li(d,\alpha)^{4}He$. Chan Tsan Ung; (Institut des Sciences Nucleaires, Grenoble, France. CEN, Grenoble, France); Longequeue, J. P.; Beaumevieille, H. Nucl. Phys., A124: 449-63(1969). (In French).

Experimental results of the reaction $^{6}Li(d,\alpha)$ were fitted using the complex eigenvalue theory. Different possible level schemes were examined with the penetration factors defined by $\Pi_c = \epsilon_c^2 k_c^{2l}$ and $P_c = 1/(F_c^2 + G_c^2)|_{r_c=a_c}$. Good fits were obtained with the following level schemes: 0^+(≈22.7 MeV) 4^+(≈22.7 MeV) 2^+(≈25 MeV); 2^+(≈22.6 MeV) 4^+(≈22.6 MeV) and 2^+(≈ 25.1 MeV). The level scheme 2^+(22.54 MeV) 0^+(24.02 MeV) 2^+(25.23 MeV) suggested by Mani is also possible. Therefore it is impossible to define the best set with the reaction $^{6}Li(d,\alpha)$ only. (auth)

15375 INTERNAL BREMSSTRAHLUNG IN THE SUPERALLOWED DECAY OF THE POSITRON EMITTER ^{11}C. Berenyi, D.; Scharbert, T.; Vatai, E. (Inst. of Nuclear Research, Debrecen, Hungary). Nucl. Phys., A124: 464-8(1969).

The internal bremsstrahlung in the superallowed decay of the β^+ emitter ^{11}C was studied in order to check the fundamental concept of the internal bremsstrahlung process. (auth)

15376 ^{10}B GAMMA-RAY BRANCHING RATIOS. Young, F. C.; Hornyak, W. F. (Univ. of Maryland, College Park). Nucl. Phys., A124: 469-74(1969).

Coincidence measurements with the $^{11}B(^{3}He,\alpha\gamma)^{10}B$ reaction were used to determine electromagnetic branching ratios for levels at 1.74, 2.15 and 3.59 MeV in ^{10}B. Suggested best values for these ratios are given. Similar measurements for levels

at 4.77 and 5.16 MeV and an unresolved group of levels at 6 MeV determined the ratio of the γ-ray partial width to the total width for these levels. (auth)

15377 THE $^{16}O(^3H,p)^{18}O(g.s.)$ REACTION CROSS SECTION WITH VELOCITY-DEPENDENT POTENTIALS. Lim, T. K. (Univ. of Malaya, Lumpur). Nucl. Phys., A124: 475-80(1969).

The absolute value of the differential cross section of the $^{16}O(^3H,p)^{18}O(g.s.)$ reaction was determined using the DWBA method of Mathur and Rook. The nucleon–nucleon interactions are central velocity-dependent potentials of exponential form while the triton ground state is taken to contain S and S′ states only, whose spatial functions are of product form with short-range correlations. The results are in good agreement with the hard-core calculations of Mathur and Rook and with experiment. Also, an independent evaluation was obtained of $P_{S'}$, the probability of the S′ state in the triton. (auth)

15378 DYNAMICAL NUCLEON–NUCLEON CORRELATIONS IN THE ^6Li, ^{12}C, AND ^{16}O NUCLEI FROM ELASTIC ELECTRON SCATTERING. Malecki, A. (Inst. of Nuclear Physics, Krakow); Picchi, P. Nuovo Cim., Lett., 1: 81-6(Jan. 11, 1969).

The effects of short-range nucleon–nucleon correlations on the elastic form factors for ^{12}C, ^6Li, and ^{16}O were studied expressing the shell-model form factors in terms of the matrix elements between the two-particle states. The results are in drastic disagreement with previous calculations that were based on the Jastrow method with the single correlated pair approximation. The correlation corrections provide much better agreement with the data for ^6Li, but are less important for the heavier nuclei. It appears that the single correlated pair approximation considerably overestimates the effect of the short-range correlations. (D.C.W.)

15379 THE POSITRON DECAY OF ^{10}C AND THE ft VALUE OF THE SUPERALLOWED FERMI TRANSITION $^{10}C(\beta^+)^{10**}B$. Freeman, J. M. (Atomic Energy Research Establishment, Harwell, Eng.); Jenkin, J. G.; Murray, G. Nucl. Phys., A124: 393-400(1969).

The energies and relative intensities of the γ rays following the positron decay of ^{10}C to ^{10}B were studied in order to determine accurately the beta end-points and branching ratios in the decay. The energies of the first two excited states of ^{10}B were measured as 718.32 ± 0.09 and 1740.16 ± 0.17 keV, respectively. The branching ratios for the positron decay to the first, second, and third excited states were found to be 98.48, 1.523, and 0%. The ft values for the Fermi and Gamow-Teller transitions were deduced. (auth)

15380 DIFFERENTIAL CROSS SECTIONS FOR THE $^{14}N(\alpha,p)^{17}O$ REACTION. Rose, F. A. (Univ. of Wisconsin, Madison). Nucl. Phys., A124: 305-19(1969).

Differential cross sections for the reaction $^{14}N(\alpha,p_i)^{17}O^*$ are reported for angles from 14 to 166° in the lab system and at E_α = 12.99, 13.39, 14.25, 14.5 and 18.07 MeV. Most of the previously reported levels up to $E_x(^{17}O)$ = 7.26 MeV were observed. A doubtful level at $E_x(^{17}O)$ = 6.99 MeV was confirmed. On the basis of a possible statistical compound nuclear mechanism and the use of the (2J + 1) rule, a spin of J = 7/2, 9/2 or 11/2 is suggested for the state $E_x(^{17}O)$ = 5.22 MeV. (auth)

15381 DISTORTED-WAVE ANALYSIS OF REACTIONS LEADING TO THE SINGLET DEUTERON STATE. Kolltveit, K.; Nagatani, K. (California Inst. of Tech., Pasadena). Nucl. Phys., A124: 287-97(1969).

Some (p,pn) reactions were studied within the distorted-wave Born approximation. The singlet and triplet state of the final pn system are analyzed separately, and it is shown that the contribution from the singlet state is dominating for small relative energies. The cross section is compared with the (p,d) cross section. Fair agreement with experiment is found. (auth)

15382 GROUND-STATE TRANSITION OF THE 7.28 MeV STATE IN ^{15}O. Kutschera, W.; Schwalm, D.; Povh, B. (Max-Planck-Institut fuer Kernphysik, Heidelberg. Univ., Heidelberg). Nucl. Phys., A124: 693-5(1969).

The ground-state branch of the $J^\pi = 7/2^+$ state at 7.28 MeV in ^{15}O was measured to be 3.8 ± 1.2% of the total decay. From the known lifetime of the state, the E3 transition strength can be determined to be 5.0 ± 2.5 W.u. (auth)

15383 SCATTERING OF 100 MeV PROTONS BY ^{12}C. Haybron, R. M. (Oak Ridge National Lab., Tenn.). Nucl. Phys., A124: 662-72(1969).

The applicability of the distorted-wave impulse approximation to the inelastic scattering of 100-MeV protons exciting the 2^+, 4.43-MeV and 3^-, 9.6-MeV levels of ^{12}C was investigated and the results compared to previous analyses of experiments at 156 MeV where the impulse approximation seems to give satisfactory results. The 100-MeV elastic data were fitted and calculations were performed using the collective theory of inelastic scattering to ascertain the quality of the derived optical potential and as a means to compare the 100-MeV inelastic data to the 156-MeV data. It was found that the impulse approximation at 100 MeV seemed to provide transition strengths which were weaker than was the case at 156 MeV, tentatively indicating a failure of this picture at the lower energy. (auth)

15384 SCATTERING OF 3.2 TO 4.2 MeV POLARIZED NEUTRONS BY CARBON USING A DIAMOND SCINTILLATOR. Miller, T. G. (Redstone Arsenal, Ala.); Biggerstaff, J. A. Nucl. Phys., A124: 637-40(1969).

Polarized neutrons from the $^{12}C(d,n)^{13}N$ reaction with energies from 3.2 to 4.2 MeV were scattered from carbon in a diamond scintillator. The $^{12}C(n,n)^{12}C$ polarization inferred from the measured asymmetries was compared with the polarization of carbon predicted from published phase shifts. (auth)

15385 LIFETIMES OF LEVELS IN ^{12}C, ^{13}C, AND ^{13}N. Riess, F.; Paul, P.; Thomas, J. B.; Hanna, S. S. (Stanford Univ., Calif.). Phys. Rev., 176: 1140-6(Dec. 20, 1968).

The Doppler-shift method was used to obtain lifetime limits of $\tau < 10$ fsec and $\tau < 26$ fsec for the 3.09- and 3.68-MeV levels of ^{13}C, respectively. The radiative width Γ_γ was remeasured for the 2.37-MeV state of ^{13}N in the reaction $^{12}C(p,\gamma)^{13}N$ and was found to be 0.45 ± 0.05 eV, corresponding to τ = 1.47 ± 0.15 fsec. Thus, the disagreement previously reported between the first excited analog level was not confirmed. A total width Γ = 34 ± 1 keV was found for the level in ^{13}N. The Doppler-shift limits were substantiated by observing a lifetime of 55 ± 7 fsec for the 4.43-MeV level of ^{12}C. For the 3.86-Mev level of ^{13}C, a lifetime of 9.0 psec was obtained. (auth)

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Refer also to abstracts 13983, 15346, 15372, 15381, 15431, 15510, 15512, 15513, and 15519.

15386 (PINSTECH/PHY-14) THE LOW-LYING ENERGY LEVELS IN ^{72}Ge. Ahmed, N. M.; Khan, H. A.; Ishaq, A. F. M.; Ahmad, A. A. Z.; Najam, M. R.; Khan, Z. U. (Pakistan Inst. of Nuclear Science and Technology, Islamabad. Nuclear Physics Div.). May 1968. 29p. Dep.

The decay scheme of ^{72}Ga was studied using Ge(Li) and Na(Tl) detectors. The results of the singles and pair-spectrometer measurements reveal 33 gamma lines with energies lying between 286 and 2837 keV. These were fitted into a decay scheme on the basis of the results of gamma–gamma coincidence experiments. (auth)

15387 $^{22}Ne(t,p\gamma)^{24}Ne$ ANGULAR CORRELATION STUDY. Becker, J. A.; Chase, L. F. Jr.; McDonald, R. E.; Warburton, E. K. (Lockheed Research Labs., Palo Alto, Calif.). Phys. Rev., 176: 1310-14(Dec. 20, 1968).

The 1.99-, 3.87-, and 4.76-MeV levels of ^{24}Ne were studied employing particle-γ coincidence techniques. The $^{22}Ne(t,p)^{24}Ne$ reaction was used to populate the levels in ^{24}Ne, employing incident triton bombarding energies near 2.5 MeV. Coincident p-γ pulse-height distributions were measured employing two-parameter analysis. Reaction protons were detected near 180° with respect to the incident beam direction in an annular solid-state detector, while γ-ray yields were measured at 0, 30, 45, 60, and 90° to the incident beam direction with a 10.2 × 10.2-cm NaI(Tl) crystal. The 3.87-MeV level was found to decay 90 ± 2% via cascade through the 1.99-MeV level (3.87 → 1.99 → 0), and 10 ± 2% via direct ground-state transitions. The 4.76-MeV level decays 100% via cascade through the 1.99-MeV level (4.76 → 1.99 → 0); an upper limit of 3% was placed on the 4.76 → 0 mode. Assuming spin 0 for the ^{24}Ne ground state, analysis of measured γ-ray angular distributions demands J = 2 for both the 1.99- and 3.87-MeV levels and restricts the spin of the 4.76-MeV level to J = 0, 1, or 2. The 3.87 → 1.99 transition has an (L + 1)/L multipole admixture of x = −0.15 ± 0.15. An upper limit, $\tau_m \leq 3 \times 10^{-8}$ sec, was set for the mean lifetimes of the 1.99-, 3.87-, and 4.76-MeV levels. (auth)

15388 DIRECT NEUTRON CAPTURE IN $^{59}Co(n,\gamma)^{60}Co$. Wasson, O. A.; Chrien, R. E.; Bhat, M. R.; Lone, M. A.; Beer, M. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 176: 1314-22(Dec. 20, 1968).

The variation in intensity of 40 individual γ rays produced by neutron capture in cobalt was observed for neutron energies less

than 1500 eV. The observed variations were consistent with the existence of a direct component in the radiative capture reaction mechanism. A direct-capture cross section of 9.2 ± 2.4 mb at 1-eV neutron energy was deduced for the 7.492-MeV ground-state transition. (auth)

15389 2^- ISOBARIC ANALOG RESONANCE IN THE ^{89}Y(p, n$_0$)^{89}Zr REACTION AND THE EXCITED STATES OF ^{89}Zr. Dutt, G. C.; Gabbard, F.; Egan, J. J.; Wiest, J. E. (Univ. of Kentucky, Lexington). Phys. Rev., 176: 1289-92(Dec. 20, 1968).

The (p,n) reaction on ^{89}Y was studied around the 2^- isobaric analog resonance at the proton energy of 4.807 MeV. Differential cross sections were measured for the neutron groups which leave ^{89}Zr in the ground state and the excited states at 0.592 and 1.096 MeV. Angular distributions of the neutron groups which leave ^{89}Zr in the excited states at 1.096, 1.465, and 1.645 MeV were measured. The results are compared with the predictions of Robson's theory and statistical model. (auth)

15390 ^{31}P(d,α)^{29}Si REACTION FROM 7.3 TO 12.0 MeV. Lock, G. A.; Curry, J. R.; Riley, P. J.; Shugart, C. G. (Univ. of Texas, Austin). Phys. Rev., 176: 1293-1301(Dec. 20, 1968).

Cross sections for the reaction ^{31}P(d,α)^{29}Si were measured for laboratory deuteron energies from 7.300 to 12.020 MeV. The data were analyzed in terms of Ericson fluctuation theory, from which the coherence width in ^{33}S was obtained for the whole range of data and for the data divided into halves. The fraction of the reaction proceeding via a direct mechanism was also determined by Ericson-type analysis. To obtain this fraction, it was necessary to take into account the particle decay of the compound nucleus through 3040 channels in order to calculate realistically the fluctuation damping coefficient. (auth)

15391 SCATTERING OF 24.5-MeV PROTONS FROM ^{89}Y. Benenson, W. (Michigan State Univ., East Lansing); Austin, S. M.; Paddock, R. A.; Love, W. G. Phys. Rev., 176: 1268-76(Dec. 20, 1968).

Scattering of 24.5-MeV protons from ^{89}Y was measured. Angular distributions were obtained for the ground state and the first four excited states as well as for several unresolved multiplets. The inelastic scattering data were analyzed, using the collective model and a microscopic model with and without core-polarization effects. (auth)

15392 GAMMA RAYS FROM THE DECAY OF ^{75}Ge AND ^{77}Ge. Ng, Anne (Emory Univ., Atlanta); Wood, R. E.; Palms, J. M.; Rao, P. Venugopala; Fink, R. W. Phys. Rev., 176: 1329-38 (Dec. 20, 1968).

Gamma spectra from the decay of 82.2-min ^{75}Ge and 11.3-h ^{77}Ge were studied with several sizes of high-resolution Ge(Li) detectors by singles and coincidence methods. Energies and relative intensities of 7 transitions in the decay of ^{75}Ge and 67 transitions in ^{77}Ge decay were determined. The transitions in the decay of ^{75}Ge are placed in a level scheme of ^{75}As consisting of levels at 199.2, 264.7, 468.7, and 617.8 keV. All 67 transitions in the ^{77}Ge decay are placed in a level scheme of ^{77}As with levels at 215.6, 264.4, 475.4, 632.0, 634, 795.6, 1077.4, 1094.0, 1190.3, 1214.9, 1319.7, 1339.0, 1378.2, 1384, 1399.5, 1458.3, 1494.7, 1528.4, 1539.2, 1560.8, 1573.3, 1863.9, 2000.3, 2104.9, 2110.9, 2202.2, 2244.8, 2301.7, 2342.0, 2353.4, 2436.6, and 2513.6 keV. (auth)

15393 (^{3}He,α) REACTION ON ^{89}Y AND ^{86}Kr AT 18 MeV. Fou, C. M.; Zurmuehle, R. W. (Univ. of Pennsylvania, Philadelphia). Phys. Rev., 176: 1339-45(Dec. 20, 1968).

Neutron hole states in N = 49 nuclei were studied with the (^{3}He,α) reaction on ^{89}Y and ^{86}Kr. Spectroscopic information was obtained from a distorted-wave Born-approximation analysis. Various optical potential wells were used. The results were compared and found to be in good agreement with each other. In ^{88}Y, the ground state and the first excited state (0.40 MeV) are excited by $1_{g_{9/2}}$ neutron pickup. The coupling of the unpaired $2_{p_{1/2}}$ proton to the $1_{g_{9/2}}$ neutron hole yields 4^- and 5^- states. Assuming that these two states represent the total T < $_{g_{9/2}}$ neutron pickup strength in ^{89}Y, the sum of their spectroscopic factors is normalized to 10. Using the same normalization factor for ^{85}Kr states, the spectroscopic factor for the ground state excited by $1_{g_{9/2}}$ neutron pickup represents only 60% of the total T < $_{g_{9/2}}$ neutron pickup strength. Two other possible $9/2^+$ neutron hole states were observed at 1.89- and 2.03-MeV excitation. Spectroscopic information about other neutron hole states observed is also presented. (auth)

15394 DIPOLE STATES IN ^{88}Sr. Goulard, B. (Univ. Laval, Quebec); Hughes, T. A.; Fallieros, S. Phys. Rev., 176: 1345-54 (Dec. 20, 1968).

A calculation of the dipole states in ^{88}Sr is presented. In addition to the conventional one particle–one hole configurations, the calculation includes a set of two-particle–two-hole excitations, with the additional particle-hole pair coupled to angular momentum zero and isospin zero or one. This not only increases the number of degrees of freedom but also allows for the appearance of states with definite isospin in the final results. The dipole spectrum separates now into two groups of states with definite isospin. One group corresponds to isospin T equal to that of the ground state. It contains the giant dipole resonance of the nucleus and most of the ground-state dipole strength. The states in the second group are analog states with isospin T + 1. They are fewer in number and lie systematically at higher energies relative to the members of the first group. They are also found to exhibit typical dipole features such as the presence of a coherent state at the high-energy side of the spectrum. The positions and the radiative strengths of the calculated levels are discussed. (auth)

15395 LEVEL SPECTRA OF ODD ISOTOPES OF Ga, As, Br, AND Rb IN THE CORIOLIS COUPLING MODEL WITH A RESIDUAL INTERACTION OF THE PAIRING TYPE. Scholz, W. (Univ. of Pennsylvania, Philadelphia); Malik, F. B. Phys. Rev., 176: 1355-65(Dec. 20, 1968).

Low-lying positive- and negative-parity states of odd isotopes of Ga, As, Br, and Rb in the mass region bounded by 30 < Z < 38 and 40 ≤ N ≤ 48 were calculated in the Coriolis coupling model with the incorporation of a residual interaction of the pairing type in calculating the intrinsic states. The single-particle energy levels and wave functions were first computed in a deformed well with a spin-orbit strength of $-0.26\hbar\omega_0$ and for a well-flattening parameter D between $-0.035\hbar\omega_0$ and $-0.06\hbar\omega_0$. These values are consistent with the observed location of the $1f_{5/2}$, $2p_{3/2}$, and $2p_{1/2}$ states in ^{41}Sc and ^{49}Sc. The deformation β was restricted to a range around $\beta = \pm 0.2$ which is consistent with the observed B(E2) value to the first excited 2^+ state of neighboring even-even nuclei, assuming a rotational character for this state. Using the orbitals in the deformed well as vacuum states, new particle states were calculated for a residual interaction of the pairing type, using a pairing-force strength consistent with the observed odd-even mass difference and the Bardeen-Cooper-Schrieffer (BCS) variational formalism. The complete variational calculation was carried out for the ground, the particle, and the core excited states with due consideration of the blocking effect. This procedure, which differs from the usual quasiparticle treatment, ensures that the particle and core excited states are orthonormal to each other and to the ground state and that the average particle number is conserved in each configuration. Band-head energies and the unperturbed bands built on them were calculated, using these new renormalized single-particle states and the moment of inertia obtained from the excitation energy of the first excited 2^+ state of neighboring even-even nuclei, assuming a rotational character for this state. Using the same moment of inertia and the computed wave functions of the deformed well, the Coriolis coupling matrix elements between these bands were calculated. The inclusion of the residual interaction introduces multiplicative "overlap factors" into the Coriolis coupling strength which results in a reduction of its magnitude for off-diagonal terms. These overlap factors were calculated from the BCS wave functions. Thus no arbitrary free parameters were used in the computation. The final spectra of the negative- and positive-parity states were obtained by a diagonalization procedure, using, respectively, the bands built on the 10 Nilsson states in the 1f-2p shell and on the 15 Nilsson states in the 1g-2d-3s shell. The model can correctly account for the observed ground-state spins for all nuclei in this region, the large number of negative-parity states with spins $\leq 7/2^-$ below 1-MeV excitation energy, and the occurrence of several low-lying positive-parity states, in particular a low-lying $5/2^+$, $5/2^+$ doublet. (auth)

15396 MEASUREMENTS OF THE ^{63}Cu(γ,n) AND (γ,2n) CROSS SECTIONS. Sund, R. E.; Baker, M. P.; Kull, L. A.; Walton, R. B. (Gulf General Atomic Inc., San Diego, Calif.). Phys. Rev., 176: 1366-76(Dec. 20, 1968).

The ^{63}Cu(γ,n) cross section was measured over the energy range from threshold to 25 MeV with a photon beam of 2.0% resolution which was produced by the inflight annihilation of positrons. The (γ,n) cross section was found to have a maximum value of 75 ± 6 mb at about 17.1 MeV and an integrated value up to 25 MeV of 490 ± 40 MeV mb. No structure was observed in these measurements or in additional (γ,n) measurements which were made in the region of the peak of the giant resonance with 1.5% γ-ray resolution The (γ,n) data from the present experiment were combined with the (γ,n) + (γ,pn) data from Livermore to obtain the ^{63}Cu(γ,pn) cross section, which was found to have a maximum value of 15 ± 4 mb at about 23 MeV and an integrated value up to 25 MeV of 60 ± 15 MeV mb. In addition, the ^{63}Cu(γ,2n) cross section was measured at three representative energies between threshold and

26 MeV. The maximum (γ,2n) cross section obtained was 10.0 ± 1.6 mb at 23.7 MeV. The results of the experiments are compared with previous measurements and with theory. A small bump in the (γ,n) + (γ,pn) + (γ,2n) cross section at about 23 MeV may possibly be attributed to an analog giant resonance. (auth)

15397 BETA DECAY OF ^{87}Kr, ^{88}Kr, AND ^{88}Rb. Lycklama, H.; Archer, N. P.; Kennett, T. J. (McMaster Univ., Hamilton, Ont.). Can. J. Phys., 47: 393-409(Feb. 15, 1969).

The decay of 1.3-hr ^{87}Kr, 2.8-hr ^{88}Kr, and 15-min ^{88}Rb to levels in ^{87}Rb, ^{88}Rb, and ^{88}Sr, respectively, was investigated using high-resolution Ge(Li) detectors, a plastic beta-ray detector, and gamma-gamma as well as beta-gamma coincidence techniques. Isotope separation was achieved using gas-sweeping methods. Consistent level schemes have been constructed for each isotope under study. (auth) (Canada)

15398 THE PREPARATION OF ^{67}Cu FROM ^{67}Zn IN A NUCLEAR REACTOR. O'Brien, H. A. Jr. (Oak Ridge National Lab., Tenn.). Int. J. Appl. Radiat. Isotop., 20: 121-4(Feb. 1969).

The preparation of ^{67}Cu by the ^{67}Zn(n,p)^{67}Cu reaction in a nuclear reactor was studied. Millicurie amounts were obtained from isotopically enriched ^{67}Zn targets, and the fission-neutron cross section for the reaction was found to be 0.82 ± 0.04 mb. The ^{67}Cu was separated from zinc and cobalt by a combination of anion exchange and chelate resin techniques. (auth) (UK)

15399 LIFETIME OF THE 29.4-keV LEVEL IN ^{40}K. Boulter, J. F.; Prestwich, W. V.; Arad, B. (McMaster Univ., Hamilton, Ont.). Can. J. Phys., 47: 591-4(Mar. 1, 1969).

The half-life of the first excited state of ^{40}K at 29.4 keV, populated by the ^{39}K(n,γ)^{40}K reaction, was measured using two scintillation detectors. The result obtained was $T_{\frac{1}{2}}$ = 4.26 ± .08 ns. A procedure for calibrating a time-to amplitude converter using commercial electronic modules is described. (auth) (Canada)

15400 ANALOGUE STATES IN THE s–d SHELL. Endt, P. M. (Univ., Utrecht). Nuovo Cim., Suppl., 6: 1071-83(1968).

The investigation of analog states in sd-shell through observation of (p,γ) resonances is discussed, and lifetimes and branching ratios obtained for bound states in ^{31}P using the reaction ^{30}Si(p,γ)^{31}P are presented. Analog states in ^{38}Ar are also discussed, together with the ^{43}Ca ground-state analog in ^{43}Sc. (D.C.W.)

15401 FLUCTUATION ANALYSIS OF THE ^{24}Mg(d,α)^{22}Na REACTION. Hsu, C. C.; Lin, E. K.; Wang, W. N. (Tsing Hua Univ., Taiwan). Nuovo Cim., 59B: 39-48(Jan. 11, 1969).

The ^{24}Mg(d,α)^{22}Na reaction was studied in the deuteron energy range from 1.83 to 3.05 MeV. Excitation functions were measured in steps of 25 keV at five angles between 40 and 140°. The transitions to the lowest three states of ^{22}Na have been analyzed in terms of the fluctuation theory of Ericson and of Brink and Stephen. Autocorrelation functions and probability distributions were calculated and were used to deduce values of the average fluctuation width (≈50 keV) and the average level spacing D_0(≈2 keV) in the compound nucleus ^{26}Al in the 13- to 15-MeV excitation-energy interval. The direct effect was estimated and discussed. After subtracting the direct contribution, the total cross section of the resulting compound contribution agrees with a statistical theory calculation. (auth)

15402 AVERAGE CROSS SECTIONS OF (n,2n), (n,p), AND (n,α) REACTIONS FOR FISSION NEUTRONS. Nasyrov, F. At. Energ. (USSR), 25: 437-9(1968). (In Russian).

The average cross section $\bar{\sigma}$ for fission neutrons, the effective threshold E_{eff}, and the effective cross section of the threshold reaction σ_{eff} are related in a known way. As a rule, values of E_{eff} for fission neutrons are the same as for reactor neutrons. For most reactions having a smooth increase in cross section, E_{eff} is determined by a cross section which is about $\frac{1}{3}$ σ_{eff}. Values of E_{eff}, σ_{eff}, reaction thresholds E_T, and average cross sections for fission neutrons $\bar{\sigma}$ are given for a number of (n,2n), (n,p), and (n,α) reactions. Examples of these reactions are as follows: ^{12}C(n,2n)^{11}C, ^{19}F(n,2n)^{18}F, ^{27}Al(n,α)^{24}Na, ^{51}V(n,p)^{51}Ti, ^{59}Co(n,p)^{59}Fe, ^{58}Ni(n,p)^{58}Co, ^{92}Mo(n,p)^{92}Nb, and ^{127}I(n,2n)^{126}I. Average cross sections for fission neutrons were also calculated for these reactions in which it was possible to select a value of σ_{eff}. Thus the value of $\bar{\sigma}$ was found to be 1.4 mbarns with a value of σ_{eff} = 130 mbarns for the ^{31}P(n,α)^{28}Al reaction. (TTT)

15403 DECAY OF ^{77}Br. Ardisson, G.; Ythier, C. (Faculte des Sciences, Nice). Physica, 34: 53-60(1967). (In French).

The γ spectra of ^{77}Br was studied, after chemical separation, using a Ge(Li) detector. Energies and intensities of 23 γ rays were measured. The data suggest a new level in ^{77}Se at 824.5 keV and verify the positions of levels at 162.0, 239.1, 250.0, 439.7, 520.9, 818.2, and 1006.0 keV. (J.W.R.)

15404 SPINS AND PARITIES OF LEVELS IN ^{40}Ca MEASURED WITH THE ^{39}K(p,γ)^{40}Ca REACTION. Leenhouts, H. P. (Rijksuniversiteit, Utrecht). Physica, 35: 290-312(1967).

Gamma-gamma triple angular correlation measurements were performed at eight resonances, and polarization experiments at three resonances of the ^{39}K(p,γ)^{40}Ca reaction in the proton energy range E_p = 1.1 to 2.1 MeV. Spins and parities were determined for the following ^{40}Ca levels (energies in MeV): 3.73,3$^-$; 3.90,2$^+$; 4.48,5$^-$; 5.24,2; 5.27,4$^+$; 5.61,4$^-$; 6.28,3$^{(-)}$; 6.94,(1,2); 7.29,0; 7.49,2; 9.41,2; 9.61,3$^+$; 9.65,2$^-$; 9.79,3; 9.87,1; 9.96,4$^+$; and 10.33,1. In addition, a number of γ ray multipole mixing ratios in ^{40}Ca were determined. A shell-model calculation was made with the surface delta interaction to explain the odd-parity levels. (auth)

15405 PHOTOPROTON SPECTRA FROM NATURAL SULPHUR. Abe, Ken; Kawamura, Nobuaki; Kanazawa, Masaaki; Mutsuro, Naoshi (Tohoku Univ., Sendai). J. Phys. Soc. Jap., 26: 203(Jan. 1969).

The photoproton spectrum of sulfur was measured using bremsstrahlung with an endpoint energy of 26 MeV. It was concluded that most of the photoprotons emitted from compound states with excitations of the order of 24 to 26 MeV leave the residual nuclei with excitation energies of 2 MeV or higher. (D.C.W.)

15406 LEVELS OF ^{88}Zr EXCITED WITH THE REACTION ^{90}Zr(p,t)^{88}Zr. Taketani, H.; Adachi, M.; Yoshida, Y.; Ogawa, M.; Ashibe, K. (Tokyo Inst. of Tech.). J. Phys. Soc. Jap., 26: 204(Jan. 1969).

Angular distributions of tritons from the reaction ^{90}Zr(p,t)^{88}Zr at a proton energy of 55 MeV were measured. The Q-value of the ground-state transition was determined to be –12.81 ± 0.2 MeV, and spin-parity assignments were made for the ground state and the two lowest excited states of ^{88}Zr. (D.C.W.)

15407 DECAY OF ^{81}Se. Ythier, C.; Meyer, J.-C.; Konijn, J.; Van Lieshout, R. (Instituut voor Kernphysisch Onderzoek, Amsterdam. Faculte des Sciences, Nice). Physica, 34: 559-70(1967). (In French).

The γ rays from ^{81m}Se in equilibrium with ^{81}Se were studied using a scintillation spectrometer. Gamma rays of 103.1, 180, 279, 558, 651, and 826 keV were observed. The maximum energy of the β^- spectra was 1.60 ± 0.05 MeV. The γ rays of ^{81m}Se + ^{81}Sc were also studied with a semiconductor detector and γ rays of 103.1, 179.0, 260.7, 276.1, 290.1, 538.7, 552.4, 566.2, 649.6, and 828.3 keV were observed. The results suggest the existence of levels at 276.1, 538.7, 566.2, 649.6 and 828.3 keV in ^{81}Br. (J.W.R.)

15408 LIFETIMES AND BRANCHING RATIOS OF ENERGY LEVELS OF ^{28}Si. I. Litherland, A. E.; Smulders, P. J. M.; Alexander, T. K. (Chalk River Nuclear Labs., Ontario). Can. J. Phys., 47: 639-49(Mar. 15, 1969).

The gamma rays from the ^{25}Mg(α,nγ)^{28}Si reaction were studied using alpha particles with energies ranging from 4.8 to 6.0 MeV. A 25 cm^3 Ge(Li) gamma-ray counter was used to observe the complex high-energy gamma-ray spectra at angles between 0 and 130° to the alpha-particle beam. Estimates of the nuclear lifetimes of the energy levels excited were obtained from Doppler shift attenuation measurements. The de-excitation branching ratios of the levels were also measured. The existence of a new level in ^{28}Si at 6695 keV was confirmed. The recently reported 3$^-$ level at either 6880 or 6889 keV was observed and found to be the 6880-keV member of the doublet. The enhancement of the octupole transition to the ground level of ^{28}Si was found to be 13 Weisskopf units. (auth) (Canada)

15409 LIFETIMES AND BRANCHING RATIOS OF ENERGY LEVELS OF ^{28}Si. II. Alexander, T. K.; Broude, C.; Ferguson, A. J.; Kuehner, J. A.; Litherland, A. E.; Ollerhead, R. W.; Smulders, P. J. M. (Chalk River Nuclear Labs., Ontario). Can. J. Phys., 47: 651-6(Mar. 15, 1969).

The gamma rays from the ^{25}Mg(α,nγ)^{28}Si reaction were studied for alpha-particle energies in the range 6.0 to 7.2 MeV. A 25-cm^3 Ge(Li) gamma-ray counter was used to observe the complex high-energy gamma-ray spectra at angles between 0 and 130° to the alpha-particle beam. The lifetime of the 7798-keV level was found to be 0.30 ± 0.10 ps by studying the Doppler broadening of the spectrum lines. The gamma-ray decays of the 8260-, 8328-, 8411-, 8543-, and 8587-keV levels were observed. The gamma-ray decays of the 8260- and 8543-keV levels had not been observed previously. The 8260-keV level decays to the first excited level at 1780-keV, and 8543-keV level decays only to the 4617-keV level. Information on the spin-parity combinations of these levels in ^{28}Si was obtained by a measurement of the yield of alpha particles at zero degrees to the beam in the reaction ^{16}O(^{16}O,α)^{28}Si. (auth) (Canada)

15410 LOWEST T = 2 LEVEL IN ^{28}Si OBSERVED AS A HIGHLY FORBIDDEN COMPOUND NUCLEUS RESONANCE IN ^{24}Mg + α REACTIONS. Snover, K. A.; Heikkinen, D. W.; Riess, F.; Kuan, H. M.; Hanna, S. S. (Stanford Univ., Calif.). Phys. Rev. Lett., 22: 239-41(Feb. 10, 1969).

The lowest T = 2 level in the self-conjugate nucleus ^{28}Si was observed in resonance reactions initiated by ^{24}Mg + α (ΔT = 2), but not in resonance reactions initiated by ^{27}Al + p (ΔT = 1). (auth)

15411 PROTON SPIN FLIP IN THE REACTION ^{58}Ni(p,p'γ)^{58}Ni* (1.45 MeV) AT 20 MeV. Eenmaa, J.; Schmidt, F. H.; Tesmer, J. R. (Univ. of Washington, Seattle). Phys. Lett., 28B: 321-3 (Dec. 23, 1968).

Proton spin-flip probability on ^{58}Ni was measured, and the data are adequately described by the DWBA collective model with a full Thomas spin-orbit coupling term and $\beta_2^{so} > \beta_2$. Predictions are found to be sensitive to the spin-orbit potential depth. (auth)

15412 ELASTIC AND INELASTIC SCATTERING OF NEUTRONS BY Na AT 1.51, 2.47, 4.04, AND 6.40 MeV. Fasoli, U. (Univ., Padua. Istituto Nazionale di Fisica Nucleare, Padua); Toniolo, D.; Zago, G.; Benzi, V. Nucl. Phys., A125: 227-40 (1969).

Total, elastic, and inelastic neutron cross sections for ^{23}Na have been measured at 1.51, 2.47, 4.04, and 6.40 MeV. The experimental data at 4.04 and 6.40 MeV are compared with the results of optical-model calculations for deformed nuclei in the adiabatic approximation. (auth)

15413 STRIPPING FORM FACTORS FOR THE REACTION ^{40}Ca(d,p)^{41}Ca(2.02 MeV). Pinkston, W. T. (Vanderbilt Univ., Nashville); Philpott, R. J.; Satchler, G. R. Nucl. Phys., A125: 176-92(1969).

The methods of a previous paper, in which stripping form factors were taken to be solutions of an inhomogeneous Schroedinger equation, were used to calculate the form factor for the reaction ^{40}Ca(d,p)^{41}Ca(2.02 MeV), and these form factors were used in distorted-wave studies of this reaction. The ground state of ^{40}Ca was assumed to have a 2-hole-2-particle impurity, $(1d_{\frac{3}{2}})^{-2}(1f_{\frac{7}{2}})^2$. The $\frac{3}{2}^-$ level at 2.02 MeV in ^{41}Ca was assumed to consist entirely of the configuration, $(1d_{\frac{3}{2}})^{-1}(1f_{\frac{7}{2}})^2$. It was found that both the magnitudes and shapes of the differential cross sections are sensitive to the form of the interparticle interaction assumed in the form factor calculation. In all cases the spectroscopic factors obtained from using the more realistic model were larger than those obtained from the conventional procedure of using a Woods-Saxon eigenfunction as form factor. The suggestion that the cross sections should be sensitive to the presence of a $2d_{\frac{5}{2}}$ component in the wave function of the ^{41}Ca 2.02 MeV level was studied. A set of coupled equations for the $1d_{\frac{3}{2}}$ and $2d_{\frac{5}{2}}$ components of the form factor were derived. When combined these components are shown to yield a form factor which is identical to the solution of the inhomogeneous equation. The analysis of the 2d component in terms of the shell model leads to a simple theory for the bound radial functions of such wave function components, which, because they lie in the continuum in zero order, are probably not well represented by the usual harmonic oscillator functions. (auth)

15414 EXPERIMENTAL INVESTIGATION OF CHARGE-DEPENDENT DEVIATIONS FROM THE BETHE STOPPING POWER FORMULA. Andersen, H. H.; Simonsen, H.; Soerensen, H. (Riso Research Establishment, Roskilde, Denmark). Nucl. Phys., A125: 171-5(1969).

The stopping powers of aluminium and tantalum for 5- to 13.5-MeV protons and deuterons and 8- to 20-MeV ^{3}He and ^{4}He were measured. At identical velocities, the ratio between the stopping powers for the double-charged and the single-charged ions is systematically higher than the factor four predicted by the Bethe formula. The deviation is 2.6% in Ta and 1.3% in Al at velocities corresponding to E_p = 2.5 MeV. The relative correction is roughly proportional to E^{-1}. (auth)

15415 DECAY OF 1.3-min ^{82}Rb TO LEVELS IN ^{82}Kr. Raman, Subramanian; Pinajian, John J. (Oak Ridge National Lab., Tenn.). Nucl. Phys., A125: 129-39(1969).

The spectra from ^{82}Rb ($T_{\frac{1}{2}}$ = 1.3 min) were measured with a 30 cm^3 Ge(Li) detector in singles and in coincidence with a 12.7 cm × 12.7 cm NaI(Tl) scintillation detector. Ten γ rays were observed. Portions of the γ spectrum from ^{82}Br($T_{\frac{1}{2}}$ = 35.5h) were also studied. It is proposed that the decay of ^{82}Rb ($J^\pi = 1^+$) populate levels in ^{82}Kr at 2171.8, 2480, 2945, and 3190 keV in addition to the known levels at 776.55 and 1474.9 keV. Limits on probable spin and parity values for the newly introduced levels were established. (auth)

15416 LEVELS OF ^{88}Sr FROM THE DECAY OF ^{88}Rb. Ragaini, R. C.; Knight, J. D. (Los Alamos Scientific Lab., N. Mex.). Nucl. Phys., A125: 97-110(1969).

The decay of 17.8-min ^{88}Rb to levels of ^{88}Sr was examined with the use of Ge(Li) and NaI(Tl) γ-ray detectors and a $\gamma-\gamma$ coincidence spectrometer. Observation of the decay of the β-ray activity gave a half-life of 17.78 ± 0.11 min. Some 14 γ rays were observed and placed in a decay scheme. On the basis of the proposed decay scheme and of a direct comparison of total β-ray activity with the intensity of the 1836-keV γ ray, it was determined that 76.2 ± 4.0% of the β disintegrations proceed to the ground state. The remainder populate ^{88}Sr levels at 1836, 2734, 3220, 3488, 3635, 4414, 4513, 4745, 4845, and 4854 keV. The properties of the levels are discussed in the framework of the quasi particle and spherical vibrational models. (auth)

15417 PROTON PICK-UP FROM THE 1p AND 2s–1d SHELLS OF ^{27}Al. Wagner, G. J. (Max-Planck-Institut fuer Kernphysik, Heidelberg); Mairle, G.; Schmidt-Rohr, U.; Turek, P. Nucl. Phys., A125: 80-96(1969).

Energy spectra and angular distributions of ^{3}H particles from the ^{27}Al(d,^{3}He)^{26}Mg reaction were measured at an incident energy of 52 MeV. An 11-MeV excitation range in ^{26}Mg was covered. Below 4-MeV final excitation, the DWBA spectroscopic factors agree with shell-model predictions but disagree with those from a simple rotational model. Above 4 MeV, some evidence in favor of a rotational band structure of the hole states was found. Negative-parity hole states were observed at an energy much lower than expected from (p,2p) experiments. The application of the DWBA to the pick-up of strongly bound protons requires optical potentials with modified radii in the exit channel. (auth)

15418 SPECTROSCOPIC STUDY OF ^{49}Ti. Andersen, S. Asgaard (Univ. of Copenhagen); Hansen, Ole; Vistisen, L.; Chapman, R.; Hinds, S. Nucl. Phys., A125: 65-79(1969).

The ^{50}V(t,α) and ^{50}Ti(d,t) reactions leading to ^{49}Ti were studied at bombarding energies near 13 MeV with an overall energy resolution of about 15 keV FWHM, and the ^{49}Ti(p,p') process was investigated at 10 MeV incident energy with 5 keV resolution. A distorted-wave analysis of the (t,α) and (d,t) cross sections is presented, and the spectroscopic information is compared to recent model predictions. Several high-spin states of the $1f_{\frac{7}{2}}$ shell configurations were identified. A consistent level scheme for ^{49}Ti is proposed, and a sum-rule analysis of the l_p = 3 (t,α) strengths for multipole orders λ = 1 and 2 is given. (auth)

15419 SPIN CUT-OFF EVALUATION FOR SOME (n,2n) REACTIONS AT 14 MeV. Guidetti, M.; Oldano, C. (Istituto di Fisica Sperimentale, Turin). Nuovo Cim., Lett., 1: 95-6(Jan. 11, 1969).

The method of Huizenga and Vandenbosch for the evaluation of the spin cut-off parameter from isomeric cross-section ratios was systematically applied to (n,2n) reactions induced by 14-MeV neutrons. The method was extended to medium-weight nuclei through recently reported ratios and through reactions for which the cross section of only one isomer was measured; for the latter case the (n,2n) cross section was obtained by the method of Pearlstein. Results are presented for reactions leading to the nuclei ^{75}Ge, ^{117}Sn, ^{119}Te, ^{121}Te, ^{127}Te, and ^{129}Te. (D.C.W.)

15420 EXCITATION ENERGIES OF LEVELS IN ^{31}P. Moss, C. E. (California Inst. of Tech., Pasadena). Nucl. Phys., A124: 440-4(1969).

A silicon target enriched in ^{29}Si was bombarded with 9-MeV ^{3}He^{++} particles, and the emitted protons were observed with a magnetic spectrometer. A silicon target enriched in ^{30}Si was bombarded with 10-MeV ^{3}He^{++} particles, and the emitted deuterons were also observed with a magnetic spectrometer. The excitation energies of 45 levels in ^{31}P were determined, and the results were compared with previous results. (auth)

15421 ENERGY DEPENDENCE OF β-(CIRCULARLY POLARIZED γ) CORRELATIONS. Mehling, O.; Daniel, H. (Max Planck Inst. of Nuclear Physics, Heidelberg). Nucl. Phys., A124: 320-36 (1969).

An apparatus was constructed for measuring β-(circularly polarized γ) correlations simultaneously as a function of the β energy and the angle θ between β and γ rays. The circular polarization of the γ radiation was detected by means of Compton forward scattering. In order to get optimum experimental conditions, two different set-ups were chosen for investigating allowed and first-forbidden β transitions, respectively. For the study of allowed transitions, a conventional set-up was constructed using a cylindrical magnet and one β counter only. The experimental set-up for the investigation of first-forbidden transitions consists of two β counters for the two mean angles $\bar{\theta}$ = 140° and $\bar{\theta}$ = 160° and a 100° cylindrical segment magnet. The β-energy

dependence is recorded by a multichannel analyzer divided into four quarters. With the set-up for allowed transitions, the (v/c) dependence of the β-(circularly polarized γ) correlations of the allowed β transitions of ^{22}Na and ^{60}Co was investigated for the energy range of $E_\beta > 44$ keV. The results are in good agreement with the predicted v/c dependence. With the set-up for first-forbidden decays, the energy dependence of the first-forbidden β transition of ^{86}Rb was measured. (auth)

15422 INTERNAL CONVERSION OF THE s-ELECTRONS IN THE LOW-Z REGION (320-keV TRANSITION IN ^{51}V). Dragoun, O. (Max-Planck-Institut fuer Kernphysik, Heidelberg); Ribordy, Cl.; Huber, O. Nucl. Phys., A124: 337-49(1969).

No precise internal conversion coefficients (ICC) are available for Z < 25. In order to test the approximate K- and L-ICC of Dranicina and Listengarten as well as the screening correction of Church for the M-ICC, the relative conversion line intensities were measured for the 320.0 keV M1 + (12.4 ± 2.4) % E2 transition in ^{51}V. The results are K/L = 11.3 ± 0.6 and L/M = 5.1 ± 0.6. The experimental screening factor f_{exp} for the M_1-ICC is 0.33 ± 0.04, which agrees with the ratio of screened and unscreened bound state electron densities near the nucleus (0.327). Methods to obtain the K-, L- and M-ICC for the low-Z region are given. (auth)

15423 SIMILAR DEEXCITATION OF THE NEIGHBORING LEVELS FORMED IN THE REACTION ^{28}Si(α,γ)^{32}S. Vernotte, J. (Institut de Physique Nucleaire, Orsay, France); Langevin, M.; Fortier, S.; Bozek, E.; Chevallier, A.; Pape, A. J.; Sens, J. C. Nucl. Phys., A124: 350-62(1969). (In French).

The 10.23- and 10.29-MeV ^{32}S levels were observed through the reaction ^{28}Si(α,γ)^{32}S (E_α = 3.753 and 3.820 MeV). The decay scheme was studied using NaI(Tl) and Ge(Li) detectors. Angular correlation measurements determine the spin of the 4.465-MeV level as J = 4. Branching ratios and multiple mixing ratios are given. The 10.23- and 10.29-MeV levels of ^{32}S might be a split isobaric analogue state, since both levels have the same spin ($J^\pi = 3^-$), and very similar branching ratios with strong branches to the relatively highly excited state with $J^\pi = 3^-$ at 5.012 MeV. Moreover, the $3^- \rightarrow 3^-$ transitions are strong (≥0.3 Wu and ≥ 0.1 Wu) and have pure M1 character. The parent state might be the 3.324-MeV level of ^{32}P. (auth)

15424 CORE EXCITED STATES IN ^{40}Ca. Federman, P. (Rutgers - The State Univ., New Brunswick, N. J.). Nucl. Phys., A124: 363-8(1969).

An extension of the usual models for dealing with core-excited states in light nuclei is proposed. The case of 4p-4h excitations in ^{40}Ca is considered, and the J = T = 0 levels calculated. It is shown that 4p-4h states, which are usually neglected, can have rather low excitation energies, and therefore it might be unnecessary to include more complicated configurations to explain low-lying J = 0 states in ^{40}Ca. (auth)

15425 FLUCTUATIONS IN THE NEUTRON CROSS SECTIONS OF Si. Grimes, S. M. (Univ. of Wisconsin, Madison). Nucl. Phys., A124: 369-92(1969).

The total neutron cross section, the 15° and 30° neutron elastic scattering cross sections, the (n,α) cross sections for the four most energetic alpha groups, and the (n,p) cross sections for the four most energetic proton groups were measured for Si with 30-keV resolution in the energy range 6.7 to 13.4 MeV. The average (n,p) and (n,α) cross sections agree within errors with the values obtained from a Hauser–Feshbach calculation. A fluctuation analysis was performed to determine the origin of the fluctuations in the cross sections. The magnitude of the fluctuations and the lack of correlation between fluctuations in different partial cross sections may be explained by Ericson interference effects. The results of the Hauser–Feshbach calculation and the fluctuation analysis indicate that direct interaction contributions to the (n,p) and (n,α) cross sections are small in this energy region. No evidence for intermediate states was found. (auth)

15426 SPIN DETERMINATIONS OF ^{31}P LEVELS FROM THE ^{30}Si(p,γ) REACTION. Wolff, A. C.; Boelhouwer, W. C. R.; Endt, P. M. (Rijksuniversiteit, Utrecht). Nucl. Phys., A124: 273-86 (1969).

The angular distributions of primary and secondary γ-ray transitions at seven resonances in the ^{30}Si(p,γ)^{31}P reaction were measured with a 30 cm^3 Ge(Li) detector. The strengths of the resonances between 800 and 1000 keV and the strength of the E_p = 2187 keV resonance were determined. The mean lifetime τ_m (or upper limits) for the ^{31}P 5.33-, 5.56-, and 5.67-MeV levels was obtained from γ-ray Doppler shift measurements as <37, <25, and 45 ± 20 fs, respectively. The measurements lead to the following J^π assignments of ^{31}P bound states and resonance levels: $J^\pi(4.63) = \frac{7}{2}^+$ ($\frac{5}{2}^+$), $J^\pi(5.01) = \frac{3}{2}$($\frac{1}{2}^-$), $J^\pi(5.02) = \frac{1}{2}$($\frac{3}{2}^+$), $J^\pi(5.53) = \frac{7}{2}$($\frac{5}{2}^+$), $J(5.56) = \frac{3}{2}$, $J(5.67) = \frac{5}{2}$, $J(6.40) = \frac{7}{2}$, $J(6.93) = (\frac{5}{2},\frac{7}{2})$, $J(8.22) = \frac{7}{2}$ and $J^\pi(8.23) = \frac{5}{2}^-$. There are strong arguments which allow to identify the 5.01- and 5.67-MeV levels with the $2p_{\frac{1}{2}}$ and $1f_{\frac{7}{2}}$ single particle states, respectively. The even-parity states in ^{31}P up to 5.8 MeV are compared with recent many-particle shell-model calculations. (auth)

15427 DIFFERENTIAL RANGE STUDY OF (α,xn) REACTIONS OF COPPER. Porile, N. T.; Fujiwara, I. (Purdue Univ., Lafayette, Ind.). Phys. Rev., 176: 1166-76(Dec. 20, 1968).

The differential ranges of the ^{63}Cu(α,n), ^{65}Cu(α,2n), and ^{65}Cu(α,3n) reaction products were measured in the energy range of 14 to 40 MeV by means of the electrostatic collection technique. The results were used to derive a range-energy relation for gallium recoils in H_3. Comparison with the Lindhard-Scharff-Schiott calculation indicates that the latter overestimates the importance of electronic stopping. The results were compared with a Monte Carlo evaporation calculation and were used to obtain the average values of the neutron and photon energies. The information obtainable from transformation of the recoil velocity distribution between the center-of-mass and laboratory systems was explored. These various analyses all indicate that the differential ranges and angular distributions of the recoils yield mutually consistent results. (auth)

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Refer also to abstracts 15346, 15381, 15414, 15419, 15495, 15508, and 15516.

15428 (CERN-Trans-68-10) SPECTRA AND ANGULAR DISTRIBUTIONS OF α-PARTICLES FROM THE INTERACTION OF ACCELERATED ^{22}Ne AND ^{40}Ar IONS WITH Au AND Th NUCLEI. Kapustsik, A.; Perelygin, V. P.; Tret'yakova, S. P.; Ukraintseva, L. B. (Joint Inst. for Nuclear Research, Dubna (USSR)). Translated by J. Rice and revised by N. Mouravieff (European Organization for Nuclear Research, Geneva, Switzerland), from report JINR-P7-3041. 24p. Dep.

An abstract of this paper, prepared from the original language, appeared as NSA 21: 10002.

15429 (COO-1672-10) RADIOCHEMICAL INVESTIGATIONS OF NUCLEAR PROPERTIES. Progress Report, October 1967–September 1968. Daly, Patrick J. (Purdue Univ., Lafayette, Ind. Dept. of Chemistry). Sept. 1968. Contract AT(11-1)-1672. 19p. Dep. CFSTI.

An attempt was made to establish accurately the nucleon evaporation correction for measured ranges of recoil atoms from (α,xn) reactions. The recoils from (α,γ), (α,n), and (α,2n) reactions on ^{115}In were used in this study. Single-particle states in odd W isotopes were investigated using (d,p) and (d,t) reactions. Conversion coefficients and multipolarities of transitions in ^{181}Re were obtained from a study of the decay of ^{181}Os isomers. A similar study of the decay of ^{182}Os yielded conversion coefficients for transitions in ^{182}Re. Gamma spectra from the decay of ^{183}Os isomers were also measured. In addition, over 300 γ transitions were identified in the decay of ^{184}Ir, and extensive $\gamma-\gamma$ coincidence measurements were made on this isotope. (D.C.W.)

15430 (MNC-3783-2) RESEARCH IN NUCLEAR CHEMISTRY AT THE UNIVERSITY OF MARYLAND. Progress Report, 1968. Viola, V. E. Jr. (Maryland Univ., College Park. Dept. of Chemistry). Nov. 1968. Contract AT(40-1)-3783. 11p. Dep. CFSTI.

The angular, kinetic energy, and mass distributions of heavy fragments from proton reactions with ^{238}U at 13 GeV/c were measured. Angular distributions of heavy fragments from proton reactions with ^{238}U at energies of 5 to 13 GeV/c were also measured. Mass predictions for elements with A > 140 by extrapolation of the observed energy systematics for β and α decay were studied; and semi-empirical relations for predicting the half-lives of heavy elements for α decay, β decay, and spontaneous fission were formulated. The production of nuclides with A > 250 in stellar nucleosynthesis was studied theoretically. The nuclear decay properties of very heavy elements were examined in order to investigate the apparent instability for nuclides with N ≥ 158. (D.C.W.)

15431 (NYO-3525-36) STUDIES OF ELECTROMAGNETIC PROPERTIES OF EXCITED STATES OF NUCLEI. Annual Progress Report for 1968. Metzger, F. R. (Bartol Research Foundation, Swarthmore, Pa.). Dec. 13, 1968. Contract AT(30-1)-3525. 57p. Dep. CFSTI.

In resonance fluorescence experiments with gaseous sources, some of the limitations of the Coulomb explosion method were explored, and rudimentary information concerning the velocity distribution of the fragments obtained. The differential cross section of lead for nonresonant elastic scattering of γ rays was measured with a Ge(Li) detector for angles ranging from 30 to 150° and for γ energies of 145, 279, 412, and 662 keV. Electric dipole transitions in ^{144}Nd and in ^{209}Bi were studied using the resonant scattering of bremsstrahlung from a Van de Graaff electron accelerator. Theoretical studies of interference effects between resonant and direct reactions were carried out; they apply also to the case of reactions proceeding either via an analog resonance or via compound states of lower isospin. Some features of E1 decays of nuclear octupole states were investigated and connected with the isospin properties of lower-lying 2^+ states. The structure of 0^+ states in some Ca isotopes was also studied in terms of paired two particle-two hole excitations of neutrons or protons relative to the ground state of the nucleus. A shell model calculation to study the structure of the calcium isotopes has been started. (auth)

15432 (ORO-2843-13) NUCLEAR CHEMISTRY GROUP PROGRESS REPORT, 1968. (Florida Univ., Gainesville). Contract AT(40-1)-2843. 52p. Dep. CFSTI.

The ternary fission of ^{239}Pu and ^{241}Pu by thermal neutrons was investigated using a triple coincidence system; the results were compared with previous coincidence data for ^{233}U and ^{235}U. A search was made for ^{32}Si among the fission products of ^{235}U at thermal energies; it was concluded that ^{32}Si is not a product of the thermal neutron fission of ^{235}U. The possibility of using tapered tubes as a means for concentrating the neutron flux at a point far removed from the reactor core was studied theoretically; it was concluded that, under optimum conditions, a flux four times as large as that produced from a curved non-tapered tube could be obtained. An experimental assembly for studying the average number of neutrons emitted in ternary fission was developed, and a time-of-flight mass spectrometer was modified for fission-fragment mass measurements. Energy spectra of long-range α particles from the thermal neutron fission of ^{235}U were measured. A time-of-flight system for dE/dx measurements on ^{235}U fission fragments as a function of energy and mass was developed. The response of thin-film scintillation detectors to fission fragments was investigated. (D.C.W.)

15433 (RLO-1388-86) CHARGE-EXCHANGE COUPLING IN ^{98}Mo + p REACTIONS. Hinrichs, R. A.; Phillips, G. W.; Cramer, J. G.; Wieman, H. (Washington Univ., Seattle. Dept. of Physics). [1968]. Contract AT(45-1)-1388. 10p. Dep. CFSTI.

The presence of isospin coupling in the incident channel is observed as anomalous behavior in ^{98}Mo + p excitation functions for proton, deuteron, and triton outgoing channels. Similarly shaped anomalies are simultaneously observed in several channels at threshold energies for the (p,n) reaction to the ground state analog and to excited state analogs of ^{98}Mo. The latter imply coupling through a deformation of the isospin-dependent potential. (auth)

15434 (UCRL-Trans-1383) MASS AND ENERGY DISTRIBUTIONS OF PHOTOFISSION FRAGMENTS OF ^{238}U, ^{209}Bi AND ^{197}Au NUCLEI. Bochagov, B. A.; Komar, A. P.; Kotov, A. A.; Ranyuk, Yu. N.; Semenchuk, G. G.; Solyakin, G. E.; Sorokin, P. V. (Akademiya Nauk SSSR, Leningrad. Fiziko-Tekhnicheskii Institut). Translated by A. M. A. Mincer for Univ. of California Lawrence Radiation Lab., Berkeley, from Preprint 123. 22p. Dep. CFSTI.

Semiconductor detectors were used to study on the Kharkov U-2000 linear accelerator the mass and energy distributions P(U,Ek) of photofission-fragment pairs of ^{238}U at $E_{\gamma,max}$ = 250, 600, and 1000 MeV and of ^{209}Bi and ^{197}Au nuclei at $E_{\gamma,max}$ = 1000 MeV. The results showed that in the fission of ^{238}U asymmetry of the mass distribution remains up to $E_{\gamma,max}$ = 1000 MeV. The "minimum" in the total kinetic energies of symmetrical nuclei is preserved at the same time. The photofission of ^{209}Bi and ^{197}Au leads to a predominantly symmetrical mass distribution and to a monotonic dependence of the total kinetic energy on the degree of the mass asymmetry of the fragments. The results on the fission of ^{209}Bi and ^{197}Au are compared with predictions of the Nix-Swiatecki theory. (auth)

15435 (WAPD-Trans-108) NEUTRON RESONANCES OF GADOLINIUM ISOTOPES. Karzhavina, E. N.; Nguyen Nguyen Phong; Popov, A. B. Translated from report JINR-P3-3882. 31p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 22: 42014.

15436 A STUDY OF THE REACTIONS ^{208}Pb(d,d)^{208}Pb AND ^{208}Pb(d,p)^{209}Pb AT ENERGIES ABOVE AND BELOW THE COULOMB BARRIER. van der Merwe, J. J.; Heymann, G. (Council for Scientific and Industrial Research, Pretoria). Z. Phys., 220: 130-44(1969).

The reactions ^{208}Pb(d,d)^{208}Pb and ^{208}Pb(d,p)^{209}Pb was studied in the energy region from below to above the Coulomb barrier. An optical-model analysis of the elastic scattering results were performed to obtain parameters for a DWBA analysis. Distorted-wave calculations for the direct transitions leading to single-particle states in ^{209}Pb were used to extract spectroscopic factors. Only two deuteron potential sets give a good account of the stripping data throughout the energy region studied. (auth)

15437 β-γ DIRECTIONAL CORRELATION AND β-(CIRCULARLY POLARIZED γ) CORRELATION IN THE FIRST FORBIDDEN DECAY OF ^{170}Tm. Daniel, H.; Martin, B.; Schmidlin, P.; Schmitt, H. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Z. Phys., 220: 181-4(1969).

The differential β-γ directional correlation and the integral β-(circularly polarized γ) correlation in the decay of ^{170}Tm were measured on the same metallic source. (auth)

15438 MONTE CARLO INTERPRETATION OF A ^{238}U SPHERICAL SHELL TRANSMISSION EXPERIMENT AT 23 keV. Miller, L. B.; Poenitz, W. P. (Argonne National Lab., Ill.). Nucl. Sci. Eng., 35: 295-7(Feb. 1969).

A Monte Carlo interpretation of the shell transmission data reported by Belanova (J. Nucl. Energy, 20: 411(1966)) for uranium was carried out to obtain the capture cross section of ^{238}U at 23 keV. Only the experimental data for the undiluted shells were used. Resonance structures for s- and p-wave interactions were generated using the appropriate statistical distributions. The potential scattering cross section was adjusted slightly to preserve the independently known total cross section of 13.4b. The average capture width was used to fit the shell transmission data. (D.C.W.)

15439 NEW ISOTOPES OF THORIUM STUDIED WITH AN IMPROVED HELIUM-JET RECOIL TRANSPORT APPARATUS. Valli, Kalevi; Hyde, Earl K. (Univ. of California, Berkeley). Phys. Rev., 176: 1377-89(Dec. 20, 1968).

Five neutron-deficient isotopes of thorium lighter than mass 218 were studied at the Berkeley Heavy Ion Linear Accelerator by bombardment of enriched ^{206}Pb with ^{16}O. Silicon (Au) surface-barrier detectors were used in on-line measurements performed to determine α-decay characteristics. Mass-number assignments of ^{213}Th through ^{217}Th were made on the basis of excitation functions and systematic trends in α-decay properties. Half-lives and α-particle energies were determined. New information was also obtained about the α-decay characteristics of ^{216}Ac, ^{215}Ra, ^{214}Fr, and ^{212}At. Systematic occurrence of complex structure in the α decay of even-Z 125-neutron nuclei is discussed, and spins and parities are suggested for three lowest-energy levels of ^{211}Ra, ^{209}Rn, and ^{207}Po. Systematic occurrence of isomerism in odd-Z 127-neutron nuclei is also discussed, and spins and parities are suggested for several levels. On the basis of the extreme regularity of the experimental α energies, predictions are made for the energies of several unknown neutron-deficient isotopes of thorium, protactinium, uranium, and neptunium. In the experimental work, the helium-jet transport method was used to remove the α-emitting products from the target region. Technical details concerning the application of the method to millisecond activities are discussed. (auth)

15440 NUCLEAR-MATTER SIZES IN THE TIN ISOTOPIC SEQUENCE. Boyd, Richard N.; Greenlees, G. W. (Univ. of Minnesota, Minneapolis). Phys. Rev., 176: 1394-1401(Dec. 20, 1968).

Differential cross sections and polarizations were measured for 39.6-MeV protons elastically scattered from ^{116}Sn, ^{118}Sn, ^{120}Sn, ^{122}Sn, and ^{124}Sn. These data were analyzed with the optical model of Greenlees, Pyle, and Tang to extract nuclear-matter rms radii. These radii are significantly greater than the corresponding proton radii, and indicate that the neutrons added between successive even isotopes are added to the surface of the neutron distribution, with the exception of the isotope pair ^{118}Sn–^{120}Sn, in which case an anomaly occurs which suggests a structural rearrangement. (auth)

15441 $g_{\frac{7}{2}}$–$h_{\frac{11}{2}}$ ANOMALY IN STRIPPING STUDIES NEAR A = 110. Cohen, B. L.; Moyer, R. A.; Moorhead, J. B.; Goldman, L. H.; Diehl, R. C. (Univ. of Pittsburgh). Phys. Rev., 176: 1401-4(Dec. 20, 1968).

Judging from summed spectroscopic factors (ΣS) in (d,p) reactions at 12 MeV, the $g_{\frac{7}{2}}$ state seems to be almost empty while the $h_{\frac{11}{2}}$ state seems to be almost full in the isotopes of Pd, Cd, and In. This is the reverse of the results in the isotopes of Sn, and is sharply contrary to expectations from nuclear-structure theory, since the $g_{\frac{7}{2}}$ state lies much lower in energy than the $h_{\frac{11}{2}}$. This

anomaly was investigated with 17-MeV-deuteron-induced (d,p) and (d,t) reactions. In the former, where the behavior is much less sensitive to the vagaries of the distorted-wave Born approximation than at 12 MeV, the same general results are obtained, although the effect is not as strong. In the (d,t) studies, there is very little anomaly in ΣS, but there are some suspicious aspects of this result. S(d,p) for exciting various $7/2^+$ nuclear levels was found to have very different ratios at 12 and 17 MeV, and S(d,p)/S(d,t) varies much more strongly than usual among these levels. It is concluded that the anomaly arises from a breakdown of the basic stripping theory. (auth)

15442 SMALL-ANGLE SCATTERING OF NEUTRONS BY HEAVY NUCLEI. Kuchnir, F. T.; Elwyn, A. J.; Monahan, J. E.; Langsdorf, A. Jr.; Mooring, F. P. (Argonne National Lab., Ill.). Phys. Rev., 176: 1405-15(Dec. 20, 1968).

The differential cross sections and polarizations of neutrons elastically scattered by U, Th, Pb, Au, W, and Cd were measured for scattering angles between 1.75 and 15°. The range of neutron energies covered is from 0.6 to 1.6 MeV. These data show no evidence for any anomalous long-range neutron-nucleus interaction. The data are used to evaluate an upper limit for the absolute value of the real part of the forward-scattering amplitude at each energy for each of the above scattering samples. The polarization of neutrons that emerge at 51° relative to the proton-beam direction in the ^{7}Li(p,n)^{7}Be reaction (the neutron-source reaction) is determined by use of these small-angle results for proton energies between 2.47 and 3.55 MeV. Some of the advantages of the use of small-angle neutron scattering as a polarization analyzer are discussed. (auth)

15443 EXPERIMENTAL STUDY OF THE (d,^{3}He) REACTION ON EVEN-A ISOTOPES OF Mo. Ohnuma, H.; Yntema, J. L. (Argonne National Lab., Ill.). Phys. Rev., 176: 1416-21(Dec. 20, 1968).

The (d,^{3}He) reactions on ^{92,94,96,98}Mo and the ^{92}Mo(^{3}He,d) reaction were studied with 23-MeV deuterons and 34-MeV ^{3}He particles. Experimental angular distributions were analyzed on the basis of the distorted-wave Born-approximation theory to determine the l values and spectroscopic factors. Results were compared with previous data and the shell-model predictions. Experimental strengths of the $g_{9/2}$ and $p_{1/2}$ components in the ground state of ^{92}Mo are consistent with the calculations. Very low-lying states with large $p_{1/2}$ and $f_{5/2}$ strength were observed. (auth)

15444 NEUTRON RESONANCES OF ^{230}Th. Cote, R. E.; Diamond, H.; Gindler, J. E.; Shwe, Hla (Argonne National Lab., Ill.). Phys. Rev., 176: 1421-3(Dec. 20, 1968).

The total neutron cross section of ^{230}Th was studied from 0.05 to about 500 eV with the Argonne fast chopper. Resonance parameters are given for many of the approximately 20 resonances observed below 300 eV. The value of the s-wave neutron strength function, based on these parameters, is $S_0 = 1.3 \times 10^{-4}$. The radiative width is $\Gamma_\gamma = 24 \pm 2$ MeV. A calculation of the resonance-capture integral leads to the value 1020 ± 30 b. Comparing this result with a direct measurement of the resonance-capture integral supports the value of 75 200 yr for the half-life of ^{230}Th used in the derivation of the latter. (auth)

15445 DETERMINATION OF TOTAL WIDTHS AND RESONANCE ENERGIES OF THE SINGLE-PARTICLE ANALOG RESONANCES IN ^{209}Bi. Wharton, W. R.; von Brentano, P.; Dawson, W. K.; Richard, Patrick (Univ. of Washington, Seattle). Phys. Rev., 176: 1424-32(Dec. 20, 1968).

Excitation functions for the inelastic scattering of protons from ^{208}Pb were obtained for incident proton energies from 14 to 18 MeV. Resonances corresponding to the first seven single-neutron isobaric analog states (IAR) of ^{209}Pb are observed. Many of the inelastic-scattering excitation functions show a resonance at only one of the IAR. These excitation functions were fitted with a five-parameter formula which consists of a resonance amplitude and an energy-independent background amplitude. For some excitation functions, additional resonance amplitudes were included. The analogs of the $g_{9/2}$ (ground-state), $i_{13/2}$(0.79-MeV), $j_{15/2}$ (1.41-MeV), $d_{5/2}$ (1.56-MeV), $s_{1/2}$ (2.03-MeV), $g_{7/2}$ (2.47-MeV), and $d_{3/2}$ (2.52-MeV) states are found to have total widths of 253 ± 10, 224 ± 20, 201 ± 25, 308 ± 8, 319 ± 15, 288 ± 20, and 279 ± 20 keV, respectively. In respective order, the resonance laboratory energies are 14.918 ± 0.006, 15.716 ± 0.010, 16.336 ± 0.015, 16.496 ± 0.008, 16.965 ± 0.014, 17.430 ± 0.010, and 17.476 ± 0.010 MeV. (auth)

15446 DECAY OF ^{103}Ag. Bakhru, H. (Yale Univ., New Haven); Morse, R. I.; Preiss, I. L. Can. J. Phys., 47: 419-27 (Feb. 15, 1969).

The decay of this isotope was studied using Ge(Li) detectors as well as with standard scintillation counters. The beta- and gamma-ray measurements confirm three beta groups of maximum energies 1.31 ± 0.05 MeV (60%), 1.03 ± 0.05 (30%), and 0.500 ± 0.1 Mev (10%) and gamma rays of energies 0.118, 0.148, 0.235, 0.268, 0.420, 0.540, 0.555, 0.585, 0.655, 0.740, 1.002, 1.1, 1.14, 1.27, 1.36, and 1.56 MeV all decaying with a half-life 1.1 hr. Coincidence studies show that the 0.118-MeV gamma ray is in coincidence with 0.148-, 0.511-, 0.555-, 0.740-, 1.0-, and 1.1-MeV gamma rays; the 0.148-MeV gamma ray with the 0.118-, 0.511-, 0.555-, 0.740-, 1.0-, and 1.1-MeV gamma rays; the 0.235-MeV gamma ray with the 0.420-, 0.511-, 0.585-, 0.740-, 1.04-, and 1.13-MeV gamma rays; the 0.540-MeV gamma ray with the 0.511- and 0.820-MeV gamma rays; and the 0.820-MeV gamma ray with the 0.511- and 0.740-MeV gamma rays only. Two beta groups of maximum energies 1.03 and 0.5 MeV are observed to be in coincidence with the 0.148- and 0.268-MeV transitions and with the 0.555- and 0.820-MeV gamma rays as a gate, only the beta group of energy 0.5 ± 0.1 MeV appears. Based on the above observation, a decay scheme of ^{103}Ag is proposed, and the results are discussed. The half-life of 118-keV level is measured by delayed coincidence and found to be $1.9 \pm 0.4 \times 10^{-9}$ sec, indicating an M1 multipolarity for this transition. The mass difference between the ground state of ^{103}Ag and ^{103}Pd is found to be 2.32 MeV. (auth) (Canada)

15447 HALF-LIVES OF SOME EXCITED STATES OF ^{125}Te. Voorthuis, H.; Beens, W.; Verheul, H. (Vrije Univ., Amsterdam). Physica, 33: 695-700(1967).

The half-lives of two excited states of ^{125}Te (at 35.3 and 462 keV) were measured by the delayed coincidence method. To obtain a good time as well as a reasonable energy resolution a so-called NPC detector was used. This detector consists of a NaI (Tl) crystal and a plastic phosphor packed in one container. The result for the first excited state at 35.3 was: $T_{1/2} = 1.535 \pm 0.081 \times 10^{-9}$ sec; and for the 462-keV level: $T_{1/2} = 4.69 \pm 0.34 \times 10^{-10}$ sec. (auth)

15448 INVESTIGATIONS OF PROMPT γ RADIATION OF FISSION FRAGMENTS IN THE SPONTANEOUS FISSION OF ^{252}Cf. Axmann, H. P. (Univ., Vienna); Ujlaki, E. Acta Phys. Austr., 27: 40-5(1968). (In German).

A Ge(Li) detector was used for the analysis of the low-energy prompt γ radiation (100 to 300 keV) of the fragments originating from the spontaneous fission of ^{252}Cf. The fission fragment spectra were detected by means of Si(Au) surface-barrier detectors. The fission fragment pulses gated the spectrum recorded in the γ-ray detector. Measurements in two different geometries produced very well-structed γ spectra and allowed to make a rough estimation of the emission time of particular γ lines. (auth)

15449 DECAY OF ^{170}Lu. Bonch-Osmolovskaya, N. A. (Joint Inst. for Nuclear Research, Dubna, USSR); Vrzal, J.; Liptak, J.; Zaitseva, N. G.; Tishin, V. G.; Urbanec, J.; Grigor'ev, E. P. Czech. J. Phys., 19: 254-72(1969). (In Russian).

The spectrum of γ radiation of the radioactive isotope ^{170}Lu was studied by means of two Ge(Li) coaxial semiconductor detectors. Around 150 γ transitions belonging to the decay of ^{170}Lu were found, and their relative intensities were determined. Using the relative intensities of the conversion electrons from other works, the internal conversional coefficients and the multipolarities of γ-ray transitions in ^{170}Yb were established. Twenty new excited levels of ^{170}Yb were introduced. A comparison of the experimental results with the predictions of the superfluid and Davydov models is made. The possible existence of $I^\pi = O^-$ excited states in the level scheme of ^{170}Yb is discussed. (auth)

15450 GAMMA-RAY SPECTRUM FROM RADIATIVE CAPTURE IN Cs. Becvar, F.; Vrzal, J.; Liptak, J.; Urbanec, J. (Joint Inst. for Nuclear Research, Dubna, USSR). Czech. J. Phys., 19: 248-53(1969). (In Czech).

The measurements of the γ-ray spectra following resonance neutron capture in ^{133}Cs, performed with the aid of a Ge(Li) detector with an active volume of about 12 cm^3, are described. The energies and intensities of a number of transitions were obtained. (auth)

15451 METHOD OF DATA PROCESSING OF TWO-DIMENSIONAL COINCIDENCE SPECTRA AND ITS APPLICATION FOR THE ANALYSIS OF γ−γ COINCIDENCE SPECTRA MEASURED IN ^{155}Tb WITH Ge(Li) DETECTORS. Galan, P. (Joint Inst. of Nuclear Research, Dubna, USSR); Kuznecova, M.; Finger, M.; Jursik, J. Czech. J. Phys., 19: 232-47(1969). (In Czech).

The method of data processing for two-dimensional coincidence spectra is described, and its application to the analysis of the γ−γ coincidence spectra in ^{155}Tb is shown. The existence of levels with energies 86.5; 105.3; 118.0; 235.2; 266.6; 268.6; 286.8; 326.0; 367.7; 427.4; 451.3; 488.8 keV in ^{155}Gd nucleus is proved on the basis of γ−γ-coincidences measured in ^{155}Tb decay with Ge(Li) detectors. Two new transitions with energies of 192 and 163 keV were found. (auth)

15452 RECOIL STUDIES OF SOME LIGHT-MASS PRODUCTS FROM THE PROTON-INDUCED FISSION OF ^{238}U AT INTERMEDIATE ENERGIES. Saha, G. B.; Yaffe, L. (McGill Univ., Montreal). Can. J. Chem., 47: 655-62(Feb. 15, 1969).

The recoil properties of ^{66}Ni, ^{67}Cu, and ^{72}Zn produced in the fission of ^{238}U by protons of 40 to 85 MeV energy were studied radiochemically by the thick target–thick catcher technique. The average kinetic energy of each product was calculated from the ranges by use of known range-energy relationships. The calculated impact velocity $v_{||}$ shows that these fission products are formed predominantly via a compound nucleus mechanism in this energy region. The average total kinetic release in fission is found to be insensitive to the bombarding energy. (auth) (Canada)

15453 GAMMA RADIATION OF ^{223}Fr. Maria, H. (Faculte des Sciences, Nice); Ythier, C.; Polak, P.; Wapstra, A. H. Physica, 34: 571-8(1967). (In French).

Energies and relative intensities were measured for more than 40 γ rays from ^{223}Fr using a Ge diode detector. The ^{223}Fr was chemically separated from its parent and daughter nuclei. (J.W.R.)

15454 THE DECAY OF ^{145}Eu. Oberski, J. E. J.; Wapstra, A. H. (Instituut voor Kernphysisch Onderzoek, Amsterdam). Physica, 34: 579-85(1967).

Gamma rays, electrons, and angular correlations were measured in the decay of ^{145}Eu. A decay scheme is proposed containing unexpectedly low positive parity states in ^{145}Sm. (auth)

15455 A NEW FAST BETA TRANSITION IN ^{181}Os. Goudsmit, P. F. A. (Instituut voor Kernphysisch Onderzoek, Amsterdam). Physica, 35: 479-82(1967).

Several cases of beta transitions with very low log ft values ($4.4 \leq \log ft \leq 4.8$) between the p[514]↑ and the n[514]↓ levels are known in the deformed region ($150 < A < 190$). A new case was identified in the decay of 2.7-min ^{181}Os. Standard spectroscopic techniques were used including measurement with a double-focusing beta spectrometer. The half-life of the [514]↑ state in ^{181}Re is found to be 0.156 ± 0.010 μs. (auth)

15456 DIRECTIONAL DISTRIBUTION OF NEUTRON-CAPTURE GAMMA-RAYS FROM ALIGNED ^{143}Nd– AND ^{145}Nd–NUCLEI. Postma, H.; Reddingius, E. R. (Kamerlingh Onnes Laboratorium, Leiden). Physica, 34: 541-55(1967).

The anisotropy of the directional distribution of neutron-capture γ rays from aligned ^{143}Nd and ^{145}Nd nuclei was measured. These isotopes were aligned in single crystals of neodymium ethylsulphate, cooled to 0.014°K by adiabatic demagnetization. High-energy capture γ rays were detected with the aid of a 3-crystal pair spectrometer. On the basis of the data obtained, it was concluded that neutron capture at approximately thermal energy is mainly due to 3-levels of the ^{144}Nd and ^{146}Nd product-nuclei. Spins of levels at 1.56, 2.28, and 2.37 MeV of ^{144}Nd are assigned as 2, 4, and 2, respectively. Also anisotropies of some low-energy γ rays are discussed. The existence of a level at 1.51 MeV with spin 3 is indicated. (auth)

15457 ANGULAR DISTRIBUTIONS OF FAST PHOTONEUTRONS FROM Pb, Bi, AND Ta. Tsubota, Hiroaki; Fujiwara, Noboru; Ishimaru, Hajime; Tanaka, Eiji; Aizawa, Teruo; Kanazawa, Masaaki; Mutsuro, Naoshi (Tohoku Univ., Sendai). J. Phys. Soc. Jap., 26: 1-8(Jan. 1969).

Using a stilbene scintillation detector, the angular distributions of fast photoneutrons of energies greater than two bias values of 7.4 and 8.7 MeV were measured for Pb, Bi, and Ta at 25.5 MeV end point energy of the bremsstrahlung. For Pb and Bi, the angular distributions were found to be asymmetric about 90 degrees with respect to the gamma-ray beam axis and were strongly peaked in a forward direction, but in the case of Ta not so obviously. The angular distributions were fitted to $W(\theta) = A + B \sin^2 \theta + C \cos \theta$, using a least squares analysis. The present experiment indicates that, in the high-energy region of the (γ,n) spectrum, C/A increases with the detecting threshold energy for neutrons and on the otherwise B/A decreases with the energy. (auth)

15458 LEVELS OF ^{178}Hf EXCITED BY THE (n,e$^-$) REACTION. Prokof'ev, P. T.; Rezvaya, G. L. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser., No. 5, 3-8 (1968). (In Russian).

By means of a β spectrograph with 0.2 to 0.4% resolution, the conversion electron spectrum of the ^{177}Hf(n,e$^-$)^{178}Hf reaction was investigated. Seventy-four γ transitions were found in the electron energy region of 70 to 2000 keV. The multipolarity of several transitions was determined. The γ transitions were found to de-excite a considerable number of the levels established by cross-over transitions from the initial state. (auth)

15459 HALF-LIVES OF ^{227}Ac AND ^{227}Th MEASURED CALORIMETRICALLY. Jordan, K. C.; Blanke, B. C. (Monsanto Research Corp., Miamisburg, Ohio). Contract AT(33-1)-GEN-53. pp 567-78 of Standardization of Radionuclides. Vienna, International Atomic Energy Agency, 1967. (MLM-1364).

The half-lives of ^{227}Ac and ^{227}Th were measured using twin heat flow calorimeters. Values of 21.7728 years and 18.7176 ± 0.0052 days, respectively, were obtained. (D.C.W.)

15460 CONVERSION ELECTRON SPECTRUM EMITTED FOLLOWING THERMAL NEUTRON CAPTURE BY ^{155}Gd NUCLEI. Berzin, Ya. Ya.; Prokofev, P. T.; Rezvaya, G. L. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser., No. 6, 3-8(1968). (In Russian).

By means of a β spectrograph, the spectrum was recorded for thermal neutron capture by ^{155}Gd nuclei with 0.1 to 0.2% resolution in the energy range 40 to 2500 keV. The internal conversion coefficients of several transitions were determined by comparing the intensities of γ rays and the conversion electron lines. Preliminary processing of the results permits calculation of the ground-state, the γ-vibrational, the β-vibrational and the octupole rotational bands. (auth)

15461 ^{96}Rh AND ^{95}Rh. Aten, A. H. W. Jr.; Kapteyn, Johanna C. (Instituut voor Kernphysisch Onderzoek, Amsterdam). Physica, 33: 705-6(1967).

Samples of enriched ^{96}Ru were bombarded with protons of 7 to 29 MeV. Two isomers of ^{96}Rh with half-lives of 1.5 ± 0.5 and 9.25 ± 1 min were identified, and a decay scheme for ^{96m}Rh was proposed. For proton energies above 17 MeV, another activity was observed with a half-life of 4.75 ± 0.5 min; this activity was attributed to ^{95}Rh. (D.C.W.)

15462 AVERAGE S- AND P-WAVE RESONANCE PARAMETERS OF ^{115}In AND ^{127}I. Furr, A. Keith; Tucker, John R. (Virginia Polytechnic Inst., Blacksburg). Nucl. Sci. Eng., 35: 364-70(Mar. 1969).

A study of the average s- and p-wave resonance parameters of ^{115}In and ^{127}I was carried out by activation of samples in a ^{10}B filtered beam of epithermal neutrons from a reactor. Neutron strength functions were obtained that are comparable to recent values obtained by total-cross-section studies but somewhat lower than earlier capture measurements. The s- and p-wave neutron strength functions for ^{115}In were found to be $0.09 \pm 0.03 \times 10^{-4}$ and $3.9 \pm 1.4 \times 10^{-4}$, respectively, and for ^{127}I, the corresponding values were found to be 0.42×10^{-4} and $9.83 \pm 0.20 \times 10^{-4}$. The average energy-dependent neutron cross sections from 1 to 100 keV were computed for both isotopes from the experimentally determined resonance parameters. (auth)

15463 ISOTOPE SHIFTS OF K X RAYS AND VARIATIONS OF NUCLEAR CHARGE RADII. Chesler, R. B.; Boehm, F. (California Inst. of Tech., Pasadena). Contract AT(04-3)-63. Phys. Rev., 166: 1206-12(Feb. 20, 1968). (CALT-63-67).

The electronic Kα_1 isotope shifts were studied for the following sets of isotopes: $^{116-124}$Sn, $^{144-150}$Nd, $^{148-154}$Sm, $^{155-156-160}$Gd, $^{182-184-186}$W, $^{200-204}$Hg, and $^{206-208}$Pb. With the help of a curved-crystal spectrometer in the Cauchois geometry, the relative wavelengths of fluorescently excited x rays for two enriched isotope samples were measured to a precision of 10^{-7}. The observed shifts, corrected for the normal and specific mass shifts, were compared with calculated shifts, taking into account the volume effect (adjusted for the dynamic quadrupole interaction), screening by the transition electron, and a term arising from the anomalous magnetic moment. The anomalies previously observed in the optical and muonic shifts are established with good accuracy by the present experiments. (auth)

15464 REVIEW OF EPITHERMAL INTEGRAL MEASUREMENTS OF NEUTRON CAPTURE AND FISSION IN ^{233}U. Gunst, S. B.; Conway, D. E. (Bettis Atomic Power Lab., West Mifflin, Pa.). Nucl. Sci. Eng., 35: 396-8(Mar. 1969).

A comparison of results reported for the capture and fission resonance integrals and the capture-to-fission ratio of ^{233}U is presented. The average values of the integral measurements are given, together with the most consistent set of values. (D.C.W.)

15465 ^{252}Cf HALF-LIFE DETERMINED BY NEUTRON COUNTING. De Volpi, A.; Porges, K. G. (Argonne National Lab., Ill.). Inorg. Nucl. Chem. Lett., 5: 111-13(Feb. 1969).

The total half-life was determined by following the neutron decay rate for 4.5 years. A sealed sample was placed in the center of a 100-cm-diameter manganese bath, and the resulting activated solution was monitored by calibrated stable counting systems. To maintain independence of neutron detection efficiency, ratios of the ^{252}Cf neutron rate against a Ra(α,n)Be neutron standard were

determined; and an increase in Ra–Be rate of 0.27%/yr was allowed for ^{210}Po alpha buildup. Results for four different sources are tabulated. A decay constant of $7.212 \pm 0.017 \times 10^{-4}$/day, equivalent to a half-life of 961.1 ± 2.3 days (2.631 ± 0.006 yr) was derived. (UK)

15466 ELECTROFISSION OF ^{238}U. Onley, D. S.; Ressler, G. M. (Ohio Univ., Athens). Phys. Rev. Lett., 22: 236-9(Feb. 10, 1969).

Calculation of the integrated electrofission cross section for ^{238}U, based on the known photofission cross section, shows that the photonuclear giant resonance can account for only about 15% of the cross section when the incident electron energy is large (≈500 MeV). The plane-wave approximation can be used; distortion of the electron wave functions produces less than 10% enhancement of the integrated cross section. Alternative mechanisms, which may contribute to electrofission, are introduced. (auth)

15467 MUONIC X RAYS IN ^{206}Pb AND POSSIBLE OBSERVATION OF NUCLEAR POLARIZATION. Anderson, H. L. (Univ. of Chicago); Hargrove, C. K.; Hincks, E. P.; McAndrew, J. D.; McKee, R. J.; Kessler, D. Phys. Rev. Lett., 22: 221-4(Feb. 10, 1969).

Muonic x rays in ^{206}Pb were measured with high precision and in addition two of the weak transitions involving the 2s state were identified and measured for the first time. The new constraints make it difficult to fit the data with Dirac energies calculated for a finite nucleus and corrected for radiative effects. Consistency can, however, be achieved by depressing the calculated 1s energy by 6.8 × 2.3 keV, an effect tentatively interpreted as due to polarization of the nucleus by the muon. (auth)

15468 CROSS SECTIONS FOR (n,2n), (n,α), AND (n,p) REACTIONS IN RARE-EARTH ISOTOPES AT 14.2 MeV. Prasad, P. Rama; Rao, J. Rama; Kondaiah, E. (Andhra Univ., Waltair, India). Nucl. Phys., A125: 57-64(1969).

Cross sections for (n,2n), (n,α), and (n,p) reactions were measured in rare-earth isotopes at 14.2 ± 0.2 MeV using the activation technique and γ-counting method. Cross sections for the following reactions are reported: ^{153}Eu(n,2n)^{152m}Eu (96 min); 91 ± 12 mb; ^{162}Er(n,2n)^{161}Er, 1870 ± 300 mb; ^{144}Nd(n,α)^{141}Ce, 9.0 ± 1.7 mb; ^{151}Eu(n,α)^{148m}Pm (43 d), 19.1 ± 3.6 mb; ^{158}Gd(n,α)^{155}Sm, 2.4 ± 0.4 mb; ^{165}Ho(n,α)^{162}Tb, 1.2 ± 0.4 mb; ^{148}Sm(n,p)^{148m}Pm (43 d); 18.8 ± 4.4 mb; and ^{148}Sm(n,p)^{148}Pm (ground state), 14.3 ± 2.3 mb. (auth)

15469 COLLECTIVE STATES OF ^{110}Cd, ^{114}Cd, AND ^{116}Cd EXCITED IN INELASTIC SCATTERING OF 55-MeV PROTONS. Koike, Masahiro; Nonaka, Itaru; Kokame, Jun; Kamitsubo, Hiromichi; Awaya, Yohko; Wada, Takeshi; Nakamura, Hitoshi (Tokyo Univ.). Nucl. Phys., A125: 161-70(1969).

Vibrational states in the doubly even nuclei ^{110}Cd, ^{114}Cd, and ^{116}Cd were investigated with inelastic scattering of 55 MeV protons. States strongly excited by E4 transitions were observed. The inelastic angular distributions for these states were analyzed on the basis of the distorted wave Born approximation. For the interaction, a first-order collective excitation was assumed. The reduced transition ratios $B(E4)/B_{s.p.}$ extracted from the analysis were several times stronger than the single-particle estimate. Possible collective hexa-decapole (2^4-pole) vibrational states are discussed. (auth)

15470 INTERMEDIATE COUPLING APPROACH IN THE UNIFIED NUCLEAR MODEL. II. ODD-MASS MOLYBDENUM NUCLEI. Choudhury, D. C.; Clemens, J. T. (Polytechnic Inst., Brooklyn). Nucl. Phys., A125: 140-60(1969).

The low-energy nuclear properties of the odd-mass molybdenum isotopes were investigated within the framework of the intermediate coupling approach in the unified nuclear model. The calculations were performed by assuming that either a last odd nucleon (particle or hole) having available to it several single-particle states or a system of nucleons (particles or holes), which can undergo excitations, is coupled to the quadrupole vibrations of the doubly even core. Diagonalization of the resulting Hamiltonian yields the low-lying spectra as well as the eigenfunctions of the respective excited states. Excellent agreement was obtained with the recent experimental level structure when realistic values were chosen for the coupling strength and for the relative particle configuration state excitation energies. The eigenfunctions obtained were used to calculate the electromagnetic transition rates, which were also in good agreement with available experimental data when the free nucleonic values for the charge and spin gyromagnetic factor were used. However, when the static nuclear moments were calculated, it become necessary to introduce the concept of "effective" nucleonic values to fit the experimental data. Finally, the validity of the approximations used in the present analysis and the circumstances in which more extensive experimental investigations are needed are discussed. (auth)

15471 APPLICATION OF ROBSON ANALOGUE THEORY TO THE ^{207}Pb(p,p′) REACTION. Ramavataram, S. (Oxford Univ.). Nucl. Phys., A125: 205-16(1969).

The Robson theory of analogue resonances based on external mixing but allowing multi-channel effects was applied to the analogue of the ground state of ^{208}Pb. Realistic potentials were used to evaluate shift and penetration factors. It was found that both the observed spreading and natural decay widths can be fitted using the same value of the channel radius. (auth)

15472 DECAY OF ^{110m}Ag: GAMMA-RAY ENERGY AND INTENSITY STANDARDIZATION. Brahmavar, S. M. (Vanderbilt Univ., Nashville); Hamilton, J. H.; Ramayya, A. V.; Zganjar, E. F.; Bemis, C. E. Jr. Nucl. Phys., A125: 217-26(1969).

The energies and intensities of the transitions from the decay of ^{110m}Ag were carefully measured with three different systems which use Ge(Li) detectors. The following energies in keV and intensities in parentheses were determined for standards: 446.77 ± 0.04 (3.5 ± 0.2), 620.22 ± 0.03 (2.9 ± 0.2), 657.71 ± 0.03 (100), 677.55 ± 0.03 (12.2 ± 0.7), 686.80 ± 0.03 (7.4 ± 0.6), 706.68 ± 0.04 (17.2 ± 0.7), 744.19 ± 0.04 (4.4 ± 0.4), 763.88 ± 0.04 (24.0 ± 0.8), 818.00 ± 0.04 (7.8 ± 0.3), 884.67 ± 0.04 (79.6 ± 2.0), 937.48 ± 0.04 (36.5 ± 1.1), 1384.22 ± 0.04 (27.7 ± 0.8) 1475.73 ± 0.04 (4.5 ± 0.2), 1504.90 ± 0.08 (14.8 ± 0.4), and 1562.22 ± 0.06 (1.33 ± 0.06). All these transitions fit into the well-known decay scheme of ^{110m}Ag. Transitions previously reported at 566.0, 667.2, 753.0, 785.0, 1443.0 keV were not observed, but weak new transitions at 626, 997, and 1334 keV were observed. Transitions of 434.00 ± 0.10, 614.37 ± 0.10 and 722.95 ± 0.08 keV were observed from the decay of ^{108m}Ag. (auth)

15473 GAMMA–NEUTRON REACTIONS IN RHODIUM AT ENERGIES BETWEEN 0.4 GeV AND 0.9 GeV. Di Napoli, V.; (Univ., Rome); Margadonna, D.; Salvetti, F.; de Carvalho, H. G.; Martins, J. Benuzzi. Nuovo Cim., Lett., 1: 308-10(Feb. 11, 1969).

Some experimental results on (γ,xn) processes in ^{103}Rh induced by photons in the energy range 0.4 to 0.9 GeV are reported. The overall errors do not exceed ±5% and ±10% of the cross section values found for (γ,n) and (γ,2n), respectively. (J.F.P.)

15474 THE (γ,n) REACTION IN GOLD AT ENERGIES BETWEEN 0.4 GeV AND 0.9 GeV. di Napoli, V. (Univ., Rome); Margadonna, D.; Salvetti, F.; de Carvalho, H. G.; Martins, J. Benuzzi. Nuovo Cim., Lett., 1: 121-2(Jan. 11, 1969).

The cross section for the reaction ^{197}Au(γ,n)^{196}Au was measured at six bremsstrahlung energies from 0.4 to 0.9 GeV. (D.C.W.)

15475 CHARGE-EXCHANGE COUPLING IN ^{98}Mo + p REACTIONS. Hinrichs, R. A.; Phillips, G. W.; Cramer, J. G.; Wieman, H. (Univ. of Washington, Seattle). Phys. Rev. Lett., 22: 301-3 (Feb. 17, 1969).

The presence of isospin coupling in the incident channel is observed as anomalous behavior in ^{98}Mo + p excitation functions for proton, deuteron, and triton outgoing channels. Similarly shaped anomalies are simultaneously observed in several channels at threshold energies for the (p,n) reaction to the ground-state analog and to excited-state analogs of ^{98}Mo. The latter imply coupling through a deformation of the isospin-dependent potential. (auth)

15476 CORRELATIONS BETWEEN (n,γ) AND (d,p) REACTIONS ON N = 82 NUCLEI. Mariscotti, M. A. J.; Moragues, J. A.; Gelletly, W.; Kane, W. R. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Lett., 22: 303-6(Feb. 17, 1969).

Correlations between the measured strengths of excitation in the (n,γ) and (d,p) reactions on the N = 82 nuclei ^{138}Ba, ^{140}Ce, and ^{142}Nd are discussed. The results are shown to be consistent with the common unique parent assumption of Lane and Wilkinson. (auth)

15477 PAIR CROSS-SECTIONS OF GAMMA-RAYS IN THE ENERGY REGION 1 TO 2 MeV IN Cd AND Au. Rama Rao, J.; Parthasaradhi, K. (Andhra Univ., Waltair, India). Curr. Sci. (India), 38: 86(Feb. 20, 1969).

The cross sections for pair production in Au and Cd were measured for γ rays of 1 to 2 MeV. The results were compared with theoretical calculations. (J.W.R.)

15478 STUDIES OF PHOTON CASCADES IN (α,2n) AND (α,3n) REACTIONS ON RARE-EARTH NUCLEI. Kavaloski, C. D. (Lowell Technological Inst., Mass.); Kossler, W. J.; Williamson, C. F. Nucl. Phys., A124: 401-11(1969).

The intensity distributions of the ground-state rotational band

γ-ray transitions were measured for four (α,2n) and (α,3n) reactions leading to the same residual doubly even deformed nuclei. For one case, γ rays were also observed in coincidence with the rotational transitions. The median angular momentum carried away by the ground-state rotational transitions was about 40% less than would be expected on the basis of a statistical model. The data indicate that the remaining angular momentum is carried away by transitions through rotational bands built on higher excited states. More accurate energy measurements were also performed for some of higher-spin rotational transitions. (auth)

15479 LEVELS, TRANSITIONS, AND ROTATIONAL STRUCTURE IN ^{227}Ac. Lange, R. C.; Hagee, G. R. (Mound Lab., Miamisburg, Ohio). Nucl. Phys., A124: 412-28(1969).

The nuclear levels in ^{227}Ac, which are populated in the α decay of ^{231}Pa, were studied by high-resolution γ-ray spectroscopy and α−γ coincidence experiments. Twenty-four previously unreported γ rays were observed in ^{227}Ac and 39 of a total of 42 γ rays were assigned to transitions in ^{227}Ac. Assignment of the γ rays was facilitated by results of α−γ coincidence studies. Data from the present work were combined with previously published α-intensity results to construct a level scheme for ^{227}Ac which includes three rotational bands with the Nilsson assignments $3/2^-[532]$, $3/2^+[651]$, and $1/2^-[530]$. (auth)

15480 DETERMINATION OF THE PARITY OF THE 1663-keV STATION OF ^{166}Er BY γ-RAY LINEAR POLARIZATION MEASUREMENTS. Herzog, P.; Weigt, P. (Univ., Bonn). Nucl. Phys., A124: 429-32(1969).

The multipolarity of the 1582-keV γ transition in the decay of ^{166}Ho was determined from a γ-γ linear polarization measurement to be almost pure E1. From this result, a negative parity can be unambiguously assigned to the 1663-keV level in ^{166}Er. (auth)

15481 THE ENERGY LEVELS OF ^{139}La AND ^{141}Pr FROM (n,n'γ) MEASUREMENTS. van der Merwe, P.; van Heerden, I. J.; McMurray, W. R.; Malan, J. G. (Southern Univ., Nuclear Inst., Faure, S. Afr.). Nucl. Phys., A124: 433-9(1969).

Using time-of-flight to discriminate against neutron induced backgrounds in a Ge(Li) detector, the energy levels of ^{139}La and ^{141}Pr were studied by means of (n,n'γ) reactions. The observed γ-rays were assigned to transitions from levels up to an excitation of 1835 keV in ^{139}La and 1844 keV in ^{141}Pr. Most of these levels had previously been observed in (n,n') measurements. Some weakly excited new levels were also observed. Structure which could not be resolved in the neutron scattering experiments but for which Hauser−Feshbach calculations had indicated higher multiplicity was shown to consist of closely spaced levels. (auth)

15482 K-SHELL PARTICLE PARAMETERS FOR E2 TRANSITIONS IN ^{152}Sm AND ^{154}Gd. Nielsen, K. Bonde; Rud, N.; Overgard, J. Chr.; Soerensen, H. E. (Univ. of Aarhus, Denmark). Nucl. Phys., A124: 445-8(1969).

The K-conversion particle parameters for E2 transitions in ^{152}Sm and ^{154}Gd are reported. The results agree with the point-nucleus theoretical values to which they were compared. (auth)

15483 BETA-GAMMA DIRECTIONAL CORRELATION OF THE OUTER GROUP DECAY IN ^{140}La. Kemper, K. W.; Murphy, R. D.; Wilkinson, R. G. (Indiana Univ., Bloomington). Nucl. Phys., A124: 298-304(1969).

The beta-gamma directional correlation involving the first-forbidden non-unique outer beta group of ^{140}La was re-measured with a precision magnetic spectrometer and found to be 10% lower than previous measurements. Values of the matrix elements determined from this measurement and existing data for other observables are presented. In terms of the extended shell model, the deduced matrix elements indicate the ground state configuration of ^{140}La to be an $f_{\frac{5}{2}}$ neutron coupled to a $g_{\frac{7}{2}}$ proton hole. (auth)

15484 LONG-RANGE ALPHA-PARTICLES AND LIGHT CHARGED NUCLEI IN THE NEUTRON-INDUCED FISSION OF ^{233}U. Cambiaghi, M.; Fossati, F.; Pinelli, T. (Univ., Pavia, Italy. Istituto Nazionale di Fisica Nucleare, Pavia, Italy). Nuovo Cim., 59B: 236-44(Feb. 11, 1969).

The various light charged particles emitted in the neutron fission of ^{233}U have been detected. The identified particles are the isotopes of hydrogen, helium, lithium, and beryllium. The yields of ^{2}H, ^{3}H, ^{3}He, ^{6}He, ^{8}He, Li, and Be relative to the long-range alpha-particle emission are given. The experimental data and the Gaussian fits of the energetic distributions are reported for ^{3}H, ^{3}He, ^{4}He, and ^{6}He. (auth)

15485 OPTICAL ORIENTATION OF THE $^3P_0$ GROUND STATE OF ^{207}Pb. Gibbs, Hyatt M. (Bell Telephone Labs., Murray Hill, N. J.); Chang, Berken; Greenhow, Rodney C. Phys. Rev. Lett., 22: 270-2(Feb. 17, 1969).

The method of optical pumping of diamagnetic atoms with zero orbital angular momentum ($^1S_0$) was extended to an atom with non-zero orbital angular momentum ($^3P_0$), yielding $|\mu_I|_{\text{uncorrected}} = 0.5726(6)\ \mu_N$ for the nuclear moment of ^{207}Pb. The cross sections for disorientation by collisions with the inert gases, hydrogen, and nitrogen are all less than 10^{-20} cm^2. (auth)

15486 RATIO OF ^{85}Kr ISOMERS PRODUCED IN MEDIUM ENERGY FISSION. McHugh, J. A.; Michel, M. C. (Univ. of California, Berkeley). Contract W-31-109-eng-52. J. Inorg. Nucl. Chem., 30: 673-6(1968). (KAPL-P-3337).

The independent isomer yields for ^{85m}Kr and ^{85}Kr in the ^{4}He induced fission of ^{232}Th and ^{235}U were obtained for mass spectrometric measurements of the relative fission yields of the krypton isotopes. It was found that a high fraction (≥0.8) of the independently formed ^{85}Kr populates the high-spin isomer for the range of compound-nucleus excitations investigated (23 to 57 MeV). (auth)

15487 A STUDY OF LEVELS POPULATED IN ^{166}Er BY THE (d,t) REACTION. Burke, D. G.; Nelson, D. E.; Reich, C. W. (Univ. of Copenhagen). Nucl. Phys., A124: 683-92(1969).

The reaction ^{167}Er(d,t)^{166}Er was studied using 12-MeV deuterons. The triton spectra were measured at lab angles of 60, 90, and 125° using a broad-range heavy-particle spectrograph. The cross sections for exciting the members of the rotational band built on the $K^\pi = 2^-$ state at 1460 keV indicate that the two-neutron configuration $\{1/2^+[633], 3/2^-[521]\}_{2^-}$ constitutes ≈50% of this band. This result is in good agreement with the predicted value of 58% for the contribution of this configuration to the $K^\pi = 2^-$ octupole vibration in ^{166}Er and thus provides further empirical evidence for the validity of the microscopic theory of collective vibrational excitations in deformed even nuclei. The population of the rotational bands built on the ground state and the levels at 787 and 1572 keV are consistent with previous assignments of the nature of these states. (auth)

15488 SHAPE FACTOR AND DIRECTIONAL CORRELATION MEASUREMENTS IN THE FIRST-FORBIDDEN BETA DECAY OF ^{139}Ba. Sunier, Jules W. (Univ. of California, Los Angeles); Berthier, Jean Contracts No. 233-(44); AT(11-1)-GEN 10 P.A. 18. Nucl. Phys., A124: 673-82(1969).

The beta-spectrum shape factor and the beta-gamma directional correlation of the $3/2^-(\beta)5/2^+(\gamma)7/2^+$ cascade in the decay of ^{139}Ba were measured as a function of the beta-particle energy. Values of the four nuclear matrix elements of the beta-decay Hamiltonian were obtained from a least-squares fitting of the experimental data to the "exact" theoretical formalism, which implies numerical calculation of the electron wave function, including nuclear finite size and finite de Broglie wavelength effects. The experimental values of these matrix elements were compared to a theoretical evaluation on the basis of the j-j coupling model. (auth)

15489 COULOMB EXCITATION IN ^{127}I. Devare, S. H.; Tandon, P. N.; Devare, H. G. (Tata Inst. of Fundamental Research, Bombay). Nucl. Phys., A124: 655-61(1969).

Coulomb excitation studies in ^{127}I were carried out at various energies up to 5 MeV using α particles from a Van de Graaff accelerator. The spectrum of de-excitation γ rays was studied with Ge(Li) solid state detector. The 58, 203, 375, and 418 keV levels were excited and the thick target yields were estimated, taking into account the γ ray branchings from the various levels. The reduced E2 transition probabilities were deduced from these measurements and were found to be $B(E2)_{203\uparrow} = 3.5 \pm 0.5 \times 10^{-2}$, $B(E2)_{375\uparrow} = 1.5 \pm 0.2 \times 10^{-2}$, and $B(E2)_{418\uparrow} = 6.1 \pm 1.2 \times 10^{-3}$ in units of $e^2cm^4 \times 10^{-48}$. Similar measurements were also made using protons of various energies up to 5 MeV to look for the excitation of higher energy levels. No evidence was found for such excitations. (auth)

15490 COULOMB EXCITATION OF $^{106\ 108\ 110}$Pd. Robinson, R. L.; McGowan, F. K.; Stelson, P. H., Milner, W. T.; Sayer, R. O. (Oak Ridge National Lab., Tenn.). Nucl. Phys., A124: 553-76 (1969).

States in the two-phonon energy region of ^{106,108,110}Pd were investigated via Coulomb excitation, which was effected with 9- and 10-MeV alpha particles and 42- to 49-MeV oxygen ions. A triplet of states of probable spin-parities 0^+, 2^+, and 4^+ was observed in each nucleus. Transition rates were extracted from the gamma-ray yields and angular distributions. Although the B(E2) values for transitions from these states to the first 2^+ states are large compared to the single-particle estimate, they are consistently smaller than the prediction of the quadrupole-phonon model. The B(E2; $2' \rightarrow 0$) values are about equal to the single-particle estimate; the B(M1; $2' \rightarrow 2$) values scatter around

$10^{-3} \times (e\hbar/2Mc)^2$. A third 2^+ state was observed in ^{110}Pd at 1212.2 keV. The B(E2) value for its ground state transition is of the order $\frac{1}{10}$ the single-particle value. A state was also Coulomb excited in each nucleus at about 2 MeV. It is attributed to octupole vibrations of the nucleus. The values for ϵB(E3; 3 → 0), where ϵ is the ratio for decay to the first 2^+ state to the total decay, in single-particle units are 25, 19, and 17 for ^{106,108,110}Pd, respectively. (auth)

15491 MEASUREMENT OF MASS AND TIME DEPENDENCE OF DELAYED FISSION NEUTRONS BY AN ON-LINE MASS SEPARATOR. Roeckl, E.; Eidens, J.; Armbruster, P. (Kernforschungsanlage, Juelich, Ger.). Z. Phys., 220: 101-29(1969).

Delayed neutron emission for thermal neutron fission of ^{235}U was investigated by means of a helium filled mass separator. At the focus of the separator, the neutron activity was detected in coincidence with the β decay preceding the neutron emission. Measurements of the activity buildup give the total delayed neutron yield and the yields for different times after fission. Measurements of the activity decay give the half-life distribution. The mass dependence of yield and half-life was investigated for the whole fission-product mass region. The splitting of the total yield of delayed neutrons between light and heavy fission products was determined. Based on Keepin's value of the total number of delayed neutrons per fission, a yield of 1.05 and 0.53 neutrons per 100 fissions was obtained for light and heavy fission products, respectively. The experimentally determined mass and time dependences of delayed neutron emission are compared with those calculated from the known precursors. Unidentified neutron activities in the mass regions 85 to 88 (half-life 1 sec) and 96 to 100 (half-life 1.5 sec) are discussed. By means of theoretical considerations the yield difference for delayed neutrons between light and heavy fission products is interpreted, and the new neutron activity is assigned to the precursors ^{99}Y or ^{99}Y. (auth)

Nuclear Theory

Refer also to abstracts 14914, 14917, 15062, 15145, 15152, 15154, 15272, 15346, 15349, 15354, 15356, 15372, 15373, 15378, 15395, 15430, 15431, 15466, and 15470.

15492 (IKF-19) TWO NUCLEON TRANSFER REACTIONS. Rabi, A. (Frankfurt Univ. (West Germany). Institut fuer Kernphysik). Sept. 1968. 21p. Dep.

The two-nucleon transfer reaction is considered, using the distorted-wave Born approximation. A finite-range potential, in Gaussian form, is used for the interaction potential in the matrix element. A Gaussian form is also taken for the internal wave function of the projectile. The J-J coupling scheme is used to describe the internal wave function of the residual nucleus. By using the Talmic transformation, the wave functions of the two captured nucleons are transformed to the wave function of the relative and the center-of-mass motion. The center-of-mass wave function is calculated for the oscillator potential with cut-off. (auth)

15493 (JAERI-1169) PROGRAM ELIESE-2: A FORTRAN-IV PROGRAM FOR CALCULATION OF THE NUCLEAR CROSS SECTIONS BY USE OF THE OPTICAL MODEL AND HAUSER-FESHBACH'S METHOD. Igarasi, Sin-iti (Japan Atomic Energy Research Inst., Tokyo). June 1968. 19p. Dep.

The computer program ELIESE-2, which calculates reaction and scattering cross sections for neutrons, protons, α particles, and some heavier particles by the optical model and the Hauser-Feshbach method, is described. The program is written in FORTRAN IV for the IBM 7090 and 7044. (D.C.W.)

15494 (UCRL-71436) THE NUCLEON-NUCLEON INTERACTION: PHENOMENOLOGICAL ANALYSES. MacGregor, Malcolm H. (California Univ., Livermore. Lawrence Radiation Lab.). Nov. 1968. 11p. (CONF-681119-1). Dep. CFSTI.

From Meeting of the American Physical Society, Miami Beach, Fla.

Nucleon-nucleon experiments from 1 to 750 MeV are considered from the standpoint of phase shift analyses. The theory put into such analyses is discussed, and the results obtained by various groups are described. (auth)

15495 MUONIC ATOMS OF ODD-MASS NUCLEI. Chen, Y. K. (Univ., Frankfurt am Main); Pieper, W. Z. Phys., 220: 185-98(1968).

The effect of the single-particle excitations on the spectra of muonic atoms with odd-mass nuclei is studied in the framework of the unified model. The theoretical spectra are compared with the experimental ones and the excitation strengths of the nuclear states as well as the nuclear polarization due to the muon are calculated. (auth)

15496 EFFECTIVE INTERACTION FOR LIGHT AND INTERMEDIATE NUCLEI. Joshi, K. P.; Mehta, G. K.; Waghmare, Y. R. (Indian Inst. of Tech., Kanpur). Phys. Rev., 176: 1154-8(Dec. 20, 1968).

A phenomenological effective interaction is derived from the matrix elements of the Yale potential tabulated by Shakin et al. The form of the central interaction is assumed to be $H_{12} = (A_W W + A_B B + A_M M - A_H H) V_c e^{-(r/r_c)^2}$, where W, B, M, and H are the usual Wigner, Bartlett, Majorana, and Heisenberg mixtures. The values of the constants A_W, A_B, A_M, A_H, V_c, and r_c are evaluated from comparison with the Yale-potential matrix elements. The parameters of the off-diagonal tensor force are also calculated in the same fashion. Calculations with the effective interaction derived in this manner are made for light and intermediate nuclei. Remarks are made about the nature of the two interactions. (auth)

15497 QUANTIZED LIQUID DROP AND SOME GROUND-STATE NUCLEAR PROPERTIES. Henry, G. Reading (Stanford Univ., Calif.). Phys. Rev., 176: 1126-9(Dec. 20, 1968).

The liquid drop is adopted as a simple nuclear model. The zero-point motion of the quantized drop is found to alter some of the properties of the classical drop, bringing the model into better agreement with experiment. The properties discussed are the skin thickness, the electric form factor for elastic scattering, and the rms nuclear radius as a function of atomic number. (auth)

15498 PROTON-PROTON BREMSSTRAHLUNG AT 47 MeV. Mason, D. L. (Oak Ridge National Lab., Tenn.); Halbert, M. L.; Northcliffe, L. C. Phys. Rev., 176: 1159-63(Dec. 20, 1968).

The cross section for proton-proton bremsstrahlung at 47 MeV was measured by detecting the two protons at 30° on either side of the beam. Strongly noncoplanar events were not accepted. The integrated cross section and differential cross section as a function of γ-ray polar angle are in reasonable agreement with recent theoretical predictions. A survey of all presently available (30°, 30°) measurements and predictions is given. (auth)

15499 EFFECTS OF USING A VELOCITY-DEPENDENT POTENTIAL IN A MONTE CARLO SIMULATION OF INTRANUCLEAR CASCADES. Chen, K.; Friedlander, G.; Miller, J. M. (Brookhaven National Lab., Upton, N. Y. Columbia Univ., New York). Phys. Rev., 176: 1208-10(Dec. 20, 1968).

A velocity-dependent potential, of the form $V = V_0(1 - \epsilon/\epsilon_{max})$ for $\epsilon < \epsilon_{max}$ and $V = 0$ for $\epsilon \geq \epsilon_{max}$, was used in a Monte Carlo simulation of intranuclear cascades. By using a reasonable ϵ_{max} (150 MeV), only slightly better agreement is obtained between the calculated and experimental results than was found previously with a velocity-independent potential. (auth)

15500 COMPARISON OF VARIATIONAL RESULTS AND SOLUTIONS OF FADDEEV EQUATION FOR A LOCAL POTENTIAL. Afnan, I. R.; Tang, Y. C. (Univ. of Minnesota, Minneapolis). Phys. Rev., 176: 1232-5(Dec. 20, 1968).

A comparison is made between the results obtained for a three-body system with a local Yukawa potential, using the Faddeev method and a variational technique. The result of this comparison shows that with the type of trial function used, the variational method yields upper and lower bounds which are very close to each other and consistent with the results obtained by Ball and Wong. On the other hand, the variational study rules out definitely the possibility of a ground-state collapse phenomenon claimed by Osborn, since Osborn's ground-state energy is even lower than the lower bound of this calculation when the potential depth is large. (auth)

15501 HINDRANCE FACTORS FOR BETA DECAYS OF HEAVY NUCLEI. Ejiri, Hiroyasu (Univ. of Washington, Seattle); Ikeda, Kiyomi; Fujita, Jun-ichi. Phys. Rev., 176: 1277-88(Dec. 20, 1968).

The schematic model proposed by Brown and Bolsterli, and applied to the giant dipole resonance, is extended to the β and γ transitions of heavy nuclei. Special emphasis is placed on the extent to which forbidden β decays of heavy nuclei are hindered because of possible giant resonances corresponding to those found in the electromagnetic transitions. A new method of calculating hindered forbidden nuclear matrix elements is proposed on the basis of the schematic model. It is shown that the hindrance factor due to the giant resonance effect is roughly 4 for the first-forbidden β transitions. Systematics of unique first-forbidden transitions are examined from this viewpoint. (auth)

15502 SYMMETRIC-CORE COLLECTIVE MODEL FOR ODD-ODD NUCLEI WITH APPLICATIONS IN THE 2s-1d SHELL.

Ascuitto, R. J.; Bell, D. A.; Davidson, J. P. (Univ. of Kansas, Lawrence). Phys. Rev., 176: 1323-8(Dec. 20, 1968).

A model for odd–odd nuclei is described in which the odd neutron and proton are coupled to a symmetric, rotating core. The Hamiltonian consists of four parts: H_R, the Hamiltonian for a rotating core of fixed shape; H_p and H_n, the Hamiltonians for a proton and a neutron moving in a symmetric oscillator potential with $l \cdot s$ and l^2 terms; and V_{pn}, the residual neutron-proton interaction. This latter was taken to have a Gaussian radial dependence with a Serber exchange mixture with parameters picked to reproduce the low-energy singlet and triplet scattering lengths. The energy eigenvalues were obtained by an exact diagonalization of the total Hamiltonian using a core-particle basis to which a truncation procedure is applied to account for the filling of the shells. The model was applied to ^{28}Al, ^{30}P, ^{32}P, and ^{36}Cl, determining the core-strength parameter P, the deformation parameter β, and the well-depth parameter λ by fitting to the known energy-level sequence. The state functions so obtained were used to calculate static magnetic dipole and electric quadrupole moments, and for ^{30}P the mixing ratio δ^2 for two 2^+ to ground transitions. The fit to the measured energy levels is quite successful; however, only in ^{28}Al and ^{30}P is the residual neutron-proton interaction needed. The values obtained for the static moments are rather poor. The results are compared, where possible, to a shell-model calculation. (auth)

15503 HIGH-ENERGY SCATTERING AT MODERATELY LARGE ANGLES. Schiff, L. I. (Stanford Univ., Calif.). Phys. Rev., 176: 1390-4(Dec. 20, 1968).

The applicability of the eikonal approximation to high-energy nucleon-nucleus and hadron-hadron collisions is limited to small angles of scattering. However, experimental results have in some cases been interpreted by applying this theory beyond its angular range of validity. In the present paper, an expression for the scattering amplitude is obtained that has much of the simplicity of the eikonal approximation, but a much greater angular range of application. It provides a natural explanation for the disagreement between the Brookhaven and Virginia data on high-energy proton-^{4}He elastic scattering in the neighborhood of the first minimum. (auth)

15504 STUDY OF NUCLEAR MATTER USING SEPARABLE POTENTIALS. Hodgson, R. J. W. (Univ. of Alberta, Edmonton). Can. J. Phys., 47: 499-508(Mar. 1, 1969).

The saturation properties of nuclear matter are determined using three different separable potentials. Results found using both second-order Hartree–Fock and an approximate reaction matrix are compared. In the latter method the angle-average approximation is examined. Calculations using the reaction matrix are straightforward and are found to be relatively insensitive to the potential forms and parameter values as long as the low-energy scattering data are satisfied. (auth) (Canada)

15505 SYSTEMATIC SURVEY OF THE $\alpha-\alpha$ INTERACTION. Afzal, S. A.; Ahmad, A. Z.; Ali, S. (International Center for Theoretical Physics, Trieste, Italy). Rev. Mod. Phys., 41: 247-73(Jan. 1969).

A systematic survey of the subject of the $\alpha-\alpha$ interaction is made. The early observations of α emission and resulting theoretical descriptions, especially the α-particle model of nuclei, are described, as are more recent $\alpha-\alpha$ scattering experiments. The latter was designed to obtain information about the nature of the $\alpha-\alpha$ interaction and about the energy levels of ^{8}Be by studying the resonance behavior of the phase shifts. The phenomenological approach, i.e., the attempt to construct the $\alpha-\alpha$ potential which reproduces the experimental phase shifts, is described as are detailed theoretical constructions of the repulsive inner part and attractive outer part of the $\alpha-\alpha$ interaction. Studies of how the $\alpha-\alpha$ interaction provides better understanding of the structure of α-clustered nuclei and also of the fundamental forces between the constituents of these nuclei are discussed. Suggestions for the direction of further efforts are made. (auth)

15506 ESTIMATION OF NUMBER OF DEGREES OF FREEDOM OF NUCLEAR REACTION WIDTHS DISTRIBUTIONS. Lycklama, H.; Kennett, T. J.; Hughes, L. B. (McMaster Univ., Hamilton, Ontario). Can. J. Phys., 47: 665-86(Mar. 15, 1969).

The effects of small sample sizes have been studied in estimating the number of degrees of freedom of nuclear reaction widths distributions using the method of maximum likelihood, the method of moments, and the method of minimization of variance. It is found that the estimates are biased as a function of the sample size and the number of degrees of freedom of the widths distribution. Bias is reduced somewhat by applying the estimation techniques to the finite sample transformation of the chi-squared distribution, the beta distribution. The efficiency of each estimation technique is indicated by comparison of the variances of the estimates to the minimum variance obtainable. A modified maximum likelihood estimator is found to be unbiased and efficient. (auth) (Canada)

15507 STUDIES IN HARTREE–FOCK THEORY CONSISTENT SYMMETRIES. Bouten, M.; Van Leuven, P. (Afdeling voor Theoretische Physica, Mol, Belgium). Physica, 34: 461-74 (1967).

Two aspects of the method of symmetry restriction of the Hartree-Fock equations are examined. These are the compatibility between particle number and imposed symmetry and the possibility of describing states with given quantum numbers by the projection method. Some specific symmetries with applicability to nuclear physics are discussed. Numerical results for light nuclei are presented. (auth)

15508 SEMICLASSICAL TREATMENT OF THE (d,d') REACTION IN THE VICINITY OF THE COULOMB BARRIER. Da Silveira, R. J. Phys. (Paris), 29: 825-8(Oct. 1968). (In French).

A semi-classical approximation is applied to deuteron inelastic scattering on ^{114}Cd in the energy range 8 to 15 MeV. Both nuclear and Coulomb excitations are taken into account, and good agreement with experiment is obtained. (auth)

15509 GAMOW–TELLER BETA DECAY IN HEAVY SPHERICAL NUCLEI AND THE UNLIKE PARTICLE-HOLE RPA. Halbleib, John A. Sr.; Sorensen, Raymond A. (Carnegie Inst. of Tech., Pittsburgh). Nucl. Phys., A98: 542-68(1967). (SC-R-67-1196).

Allowed Gamow-Teller beta decay transition rates in medium and heavy spherical nuclei are calculated using the pairing-plus-quadrupole model with additional neutron-proton forces. Even-mass transition rates from the lowest $J^\pi = 1^+$ states of doubly odd nuclei to the ground and first excited states of the doubly even nuclei are calculated. The l-forbidden and non-l-forbidden odd-mass decays between the lowest states of given spins and parities are also computed. In addition to the pairing and quadrupole forces, neutrons and protons are allowed to interact through a zero-range force and a factorable long-range force specific to Gamow-Teller beta decay. The random phase approximation for the latter is developed and demonstrated. Generally, good agreement with experiment is obtained in the 2d region, but it becomes poorer as the theory is applied to lighter nuclei. (auth)

15510 A LABORATORY MEASUREMENT OF DECAY ENERGY IN ELECTRON CAPTURE FROM INNER BREMSSTRAHLUNG SPECTRUM. Raj, K.; Ramaswamy, M. K. (Fordham Univ., Bronx, N. Y.). Amer. J. Phys., 37: 70-2(Jan. 1969).

An experiment for the measurement of decay energy in electron capture, which is suitable for an advanced undergraduate laboratory, is described. The experiment consists of determining the endpoint energy of the inner bremsstrahlung spectrum accompanying electron capture. As an example, the ^{55}Fe–^{55}Mn decay energy was measured and a value of 248 ± 20 keV was obtained. (auth)

15511 THREE-BODY FORCES IN NUCLEAR MATTER. Choudhury, S. Rai (Univ. of Michigan, Ann Arbor). Phys. Rev. Lett., 22: 234-6(Feb. 10, 1969).

It is argued that the η meson can be expected to play a significant role in generating three-body forces in nuclear matter. This seems to invalidate earlier conclusions, based on π exchange, that the effect of three-body forces in nuclear matter is insignificant. (auth)

15512 FORM FACTORS FOR TWO-NUCLEON TRANSFER REACTIONS. Jaffe, R. L.; Gerace, W. J. (Princeton Univ., N. J.). Nucl. Phys., A125: 1-27(1969).

A general expression for the differential cross section in two-nucleon transfer reactions is derived, emphasizing the role of the overlap integral of the nuclear wave functions involved. In the case of transitions to doubly magic nuclei it is found that this overlap must satisfy a familiar two-particle Schroedinger equation and can therefore be expressed as the sum of products of two single-particle wave functions. These single-particle states are taken to be eigenstates of a finite well and are bound at their experimentally determined single-particle energies. Correlations introduced by mixing several of these configurations ensure the correct energy dependence in the overlap. Angular distributions calculated using this prescription are compared to experiment and to the methods of other workers. It is found that the magnitude of the differential cross section is very sensitive to the energy with which the single-particle states are bound in the finite well. (auth)

15513 COULOMB EXCITATION NEAR THE COULOMB BARRIER. Samuel, M.; Smilansky, U. (Weizmann Inst. of Science, Rehovot, Israel). Phys. Lett., 28B: 318-20(Dec. 23, 1968).

The interference between Coulomb and nuclear excitation processes is discussed in the framework of the DWBA formalism. The conditions at which the nuclear effects start to manifest

themselves are investigated and it is shown that the usual accepted estimation of the Coulomb barrier energy gives a rather too high result. It is also shown that the interference between the two processes might serve as a tool to measure the nuclear surface parameters. (auth)

15514 RESIDUAL INTERACTION IN NUCLEI. Band, I. M.; Guman, V. N.; Sliv, L. A.; Kharitonov, Yu. I. Phys. Lett., 28B: 313-17(Dec. 23, 1968).

The range r_0 of the residual central forces in nucleus is discussed. The splitting of two-particle configurations and binding energies of n particles in a j-level are shown to be most sensitive to the range r_0. From the corresponding data analysis in the lead region the value $r_0 = (1.8 - 2.0)$ fm is obtained. It is found that levels with J = 0 and 1 are especially sensitive to the tensor forces. Possible density dependent types of the residual interaction are discussed. (auth)

15515 RADIATIVE TRANSITIONS BETWEEN RESONANT STATES. Thompson, W. J. (Univ. of Washington, Seattle). Phys. Lett., 28B: 324-5(Dec. 23, 1968).

The inclusion of resonance contributions to radiative transitions between unbound nuclear states is treated, and application made to E1 transitions between states near the 3.51 MeV ($3/2^-$) and 2.37 MeV ($1/2^+$) levels of ^{13}N, observed in $^{12}C(p,\gamma p')^{12}C$ at low energies. (auth)

15516 MAGNETIC MOMENTS AND SHORT-RANGE CORRELATIONS. Bertsch, G. F. (Palmer Physical Lab., Princeton, N. J.). Phys. Lett., 28B: 302-3(Dec. 23, 1968).

Contrary to previous assertions, Brueckner correlations do affect magnetic moments. The parameterization that emerges seems to work also for lower energy correlations. (auth)

15517 THE (p,γ) REACTION THROUGH ISOBARIC ANALOG- AND GIANT DIPOLE RESONANCES. Ejiri, H.; Bondorf, J. P. (Univ. of Washington, Seattle). Phys. Lett., 28B: 304-7(Dec. 23, 1968).

The $(p,\gamma_{E\,I})$ reaction through interfering isobaric analogue (energy $\bar{E}$) and giant dipole (E^J) resonances in medium and heavy nuclei, where $\bar{E} \approx E^J$, is discussed in terms of microscopic particle-hole intermediate states and is compared with experiments. (auth)

15518 ON THE EQUALITY OF THE MATRIX ELEMENTS M_V^2, M_A^2, M_P^2 IN MUON CAPTURE. Hrasko, P. (Central Research Inst. for Physics, Budapest). Phys. Lett., 28B: 470-1 (Jan. 20, 1969).

It is shown that in the SU(4) scheme the muon capture matrix elements are equal except for N > Z odd-odd nuclei. (auth)

15519 ORIGIN OF THE SPIN-ORBIT SPLITTING IN NUCLEAR HARTREE–FOCK CALCULATIONS. Lande, Alexander; Svenne, J. P. (Univ. of Copenhagen). Nucl. Phys., A124: 241-52(1969).

Hartree–Fock calculations were carried out for ^{16}O and ^{40}Ca with the nucleon-nucleon potentials of Hamada–Johnston and Tabakin. The resulting spin-orbit splittings are strongly volume-dependent, being too large at the saturating radius and somewhat too small at the empirical radius. It is shown how a result from the first-order shell model theory for spherical, spin-saturated nuclei may be extended to HF theory; namely, that only a two-body spin-orbit term in the two-nucleon potential can give rise to a single-particle spin-orbit splitting. The contributions from the various first- and second-order terms in the reaction matrix elements of the Hamada–Johnston potential are isolated by use of the eigenstates of a HF Hamiltonian that has been suitably averaged to remove the spin dependence introduced by the spin-orbit term in the HJ potential. The splitting is seen to originate almost entirely in the ^3P states of the long-range part of the spin-orbit term in the HJ potential, with a reduction of about 20% due to the second-order discontinuity term in the reference spectrum method used for evaluating the odd-state reaction matrix elements. (auth)

15520 POLARIZATION FROM SCATTERING POLARIZED SPIN-$1/2$ ON UNPOLARIZED SPIN-1 PARTICLES. Seyler, R. G. (Ohio State Univ., Columbus). Nucl. Phys., A124: 253-72 (1969).

The most general parity and time reversal invariant form for the spin-$1/2$–spin-1 scattering amplitude matrix is obtained. The polarization observables (cross section, spin-$1/2$ polarization, spin-1 polarization, and spin correlation) which arise upon scattering polarized spin-$1/2$ by unpolarized spin-1 particles are expressed in terms of the coefficients of this general form. A phase shift parameterization of these coefficients is also given. (auth)

15521 RESONANT ABSORPTION OF GAMMA-RAY MULTIPOLE MIXTURES WITH APPLICATIONS TO ORIENTED NUCLEI. Misra, S. K. (Sir George Williams Univ., Montreal). Nuovo Cim., 59B: 152-64(Feb. 11, 1969).

Relative absorption transition probabilities are calculated using statistical operators representing emission and absorption of gamma multipoles. The results are specialized to the case of absorption of E2-M1 mixtures in the Moessbauer spectrum of ^{57}Fe nuclei, and are tabulated for immediate experimental use. For the case of oriented absorber nuclei, an explicit linear dependence of the transmitted intensity upon the polarization of ^{57}Fe nuclei is found. (auth)

15522 SOLUTION OF THE BETHE–GOLDSTONE EQUATION. Dahll, G. (NORDITA, Copenhagen. Oslo Univ.); Oestgaard, E.; Brandow, B. Nucl. Phys., A124: 481-552(1969).

Various methods for solving the Bethe-Goldstone equation are critically reviewed from the theoretical standpoint, and are then tested in detailed calculations. The methods considered are the integral equation method of Brueckner and Gammel, the separation method of Moszkowski and Scott, the reference spectrum method of Bethe et al., Köhler's "improved separation method," and the "modified Moszkowski-Scott" method of Bethe et al. A variety of input parameters are considered. Some of the sets of parameters are appropriate for infinite nuclear matter, or equivalently, for the high-density region of the nuclear interior. Other parameter sets correspond to interactions in the nuclear surface. In all cases the intermediate-state potential energies are assumed to vanish. The quantities studied are the G-matrix elements, the two-body wave functions, Fourier transforms of the latter, and the volume of the correlation hole (the "wound integral"). Hard-core potentials were assumed: the "standard hard core potential" of Moszkowski and Scott, and the Reid $^3S_1$ potential. The latter contains a strong tensor component. The higher-order Pauli corrections of the reference-spectrum method are found to behave as a geometric series, even for the $^3S_1$ state. However, the geometric series approximation is seriously in error for the $^3D_1$ state. Also, separation methods are found to be quite unreliable for the $^3S_1$ state. The Brueckner–Gammel method is found to be rapid and convenient when the complete Green function is expressed in terms of the reference-spectrum Green function, and the matrix inversion problem is replaced by iteration of the wave equation. Approximation methods are developed for the Fourier transforms and wound integrals. (auth)

15523 RESONANCE PARAMETER DISTRIBUTIONS FOR INTERFERING RESONANCES. Freeman, Robert A. (San Diego State Coll, Calif.); Garrison, John D. Nucl. Phys., A124: 577-96 (1969).

The distributions of Kapur-Peierls or Humblet-Rosenfeld resonance parameters and spacings for a variety of interference conditions were obtained by Monte Carlo calculations in the two-resonance approximation using the distribution of R-matrix resonance parameters and spacings and the mathematical connection between the R-matrix and Kapur-Peierls cross-section formulations. The R-matrix distributions are assumed the same under all conditions of interference. (auth)

15524 CENTER-OF-MASS MOTION IN SHELL-MODEL CALCULATIONS WITH ARBITRARY CENTRAL POTENTIAL. Nissimov, H.; Unna, I. (Hebrew Univ., Jerusalem). Nucl. Phys., A124: 609-23(1969).

In the framework of the random-phase approximation it is possible to give the explicit dependence of the shell model Hamiltonian on the center-of-mass degrees of freedom. The smallness of the terms in this Hamiltonian which couple the center-of-mass to the internal degrees of freedom can be examined in every case. It was found, that for commonly used potential wells the coupling is rather small and an approximate separation is possible. The method described here can be generalized and used for the separation of other collective degrees of freedom. (auth)

15525 SOFT-CORE NUCLEON–NUCLEON POTENTIAL. Bressel, C. N.; Kerman, A. K.; Rouben, B. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)2098. Nucl. Phys., A124: 624-36(1969).

The hard cores of the Hamada-Johnston (HJ) nucleon-nucleon potential are replaced by finite square wells of larger radius (0.7 fm) and it is demonstrated that the nucleon-nucleon scattering and deuteron data are very well fitted by this specific static potential. Outside of the square-well radius the potential is the same as that of HJ except for a few small changes in some of their parameters. The pion masses differ from that of HJ in a charge-dependent way such that charge symmetry is retained. The radius of the square finite cores, which is about 0.7 fm, also has a small charge dependence such that charge symmetry is retained but charge dependence is violated. The strengths of the square cores for n-p and p-p scattering are determined by a computer

search. The search routine utilizes a chi-squared test in which the scattering and deuteron data are fitted directly. The current best fit obtained in the p-p case has a chi-squared value of about 2.0 per data point, which is smaller than that for any other potential tested against the p-p data set of Signell et al. (auth)

15526 COLLECTIVE MODEL FOR PEAR-SHAPED NUCLEI. Krappe, H. J.; Wille, U. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Nucl. Phys., A124: 641-54(1969).

The Bohr-Mottelson collective model was worked out in detail for even- and odd-mass nuclei with stable octupole deformations. Allowance was made for rotation-vibration coupling effects. The transition from octupole vibrations around a spheroidal shape to stable octupole deformation is discussed. The model was applied to the low-lying states of ^{19}F, and reasonable agreement with the experimental data was obtained. (auth)

15527 MOMENT OF INERTIA OF THE COMPOUND NUCLEUS. Gadioli-Erba, E.; Sona, P. G. (CISE, Milan. Univ., Milan). Energ. Nucl. (Milan), 14: 111-12(Feb. 1967). (CISE-E-601).

A generalized formula for the average of the square of the angular momentum for the compound nucleus is developed which contains the temperature-dependent moment of inertia. The formula is the classical limit to the corresponding statistical expression. (J.W.R.)

15528 EVALUATION OF PERTURBATION THEORY TERMS IN NUCLEAR MATTER. Ko, Che-ming; Sprung, Donald W. L. (McMaster Univ., Hamilton, Ont.). Can. J. Phys., 47: 123-30 (Jan. 1, 1969).

The second-order perturbation term in nuclear matter is reduced, for the most general nonlocal potential, to a triple quadrature. A kinematic function of three variables which includes all kinematic effects of the Pauli principle is defined and is evaluated analytically. An improved angle average approximation for nuclear matter calculations is derived and is found to be very accurate for evaluating the Pauli correction in the reference spectrum method. (auth) (Canada)

REACTOR TECHNOLOGY

Commercial Power Reactors

Refer also to abstracts 13868 and 13912.

15529 (ANL-Trans-712) SAFETY OF NUCLEAR POWER STATIONS. Gruemm, Hans. Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from Elektrotech. Maschinenbau, 85: 225-35(May 1968). 25p. Dep. CFSTI.

In contrast to various prejudices nuclear power stations represent very safe facilities as can be concluded from the accident statistics. This fact is based on a refined safety technique which exceeds by far the usual conditions in conventional engineering. Legal regulations and strict controls provide in nuclear power stations sufficient measures for the prevention of accidents and for the limitation of their consequences. The location and protective measures are adjusted in such a manner that the operation of nuclear power stations does not include any major hazards for the environment. 29 references. (auth)

15530 (DOCKET-50133-1) HUMBOLDT BAY POWER PLANT, UNIT NO. 3. Final Hazards Summary Report, Amendment 11. (Pacific Gas and Electric Co., San Francisco, Calif.). Sept. 1, 1961. 496p. Dep. CFSTI.

Information on the Humboldt Bay Power Reactor is given under the following broad topics: Introduction; Summary; Description of the Unit; Reactor Characteristics; Site and Environment; Waste Disposal; Operation; and Safety Analysis. (D.C.C.)

15531 (DOCKET-50220-1) [NINE MILE POINT NUCLEAR STATION.] APPLICATION FOR LICENSES. (Niagara Mohawk Power Corp., Syracuse, N. Y.). Apr. 1, 1964. 15p. Dep. CFSTI.

Financial data on the owners of the Nine Mile Point Power Reactor are given in support of the application for construction permit and operating license. The 1963 consolidated balance sheet for the Niagara Mohawk Power Corporation is included. (D.C.C.)

15532 (DOCKET-50220-3) [NINE MILE POINT NUCLEAR STATION.] EXTENSION OF PROVISIONAL CONSTRUCTION PERMIT CPPR-16. (Niagara Mohawk Power Corp., Syracuse, N. Y.). Oct. 17, 1967. 4p. Dep. CFSTI.

Notification of an extension of the provisional construction permit CPPR-16 for the Nine Mile Point Power Reactor is presented. (D.C.C.)

15533 (DOCKET-50220-14) NINE MILE POINT NUCLEAR STATION. Preliminary Hazards Summary Report, Vol. 1, Exhibit D. (Niagara Mohawk Power Corp., Syracuse, N. Y.). Apr. 1964. 276p. Dep. CFSTI.

Information on Nine Mile Point Power Reactor is given under the following broad topics: Introduction; Summary; Station Description; Radioactive Waste Disposal; Reactor Characteristics; Station Site and Environment; Safety Analysis; and Operations. Appendices contain information on: pressure suppression test program, and pressure suppression design. (D.C.C.)

15534 (DOCKET-50220-15) NINE MILE POINT NUCLEAR STATION. APPENDIXES. Preliminary Hazards Summary Report, Vol. 2, Exhibit D. (Niagara Mohawk Power Corp., Syracuse, N. Y.). Apr. 1964. 350p. Dep. CFSTI.

Appendices contain information for the Nine Mile Point Power Reactor on: meteorology, and limnology. The site evaluation study presents information on: field explorations, laboratory tests, geologic studies, hydrologic studies, and engineering seismology. (D.C.C.)

15535 (DOCKET-50220-16) NINE MILE POINT NUCLEAR STATION. Preliminary Hazards Summary Report, Suppl. 1, Exhibit D(Suppl. 1). (Niagara Mohawk Power Corp., Syracuse, N. Y.). Aug. 1964. 226p. Dep. CFSTI.

The answers to questions about the Nine Mile Point Power Reactor provide information on: seismic design parameters for buildings and structures; emergency auxiliary equipment; accident analysis; radiation monitoring of stock effluents; hydraulic and nuclear stability of core; environment; and containment and pressure suppression systems for coolant-loss accident. Information on maximum flow rate of a single component, two-phase mixture is presented. (D.C.C.)

15536 (DOCKET-50220-17) NINE MILE POINT NUCLEAR STATION, OSWEGO, NEW YORK. Safety Analysis by the Division of Reactor Licensing. (Niagara Mohawk Power Corp., Syracuse, N. Y.). Nov. 23, 1964. 85p. Dep. CFSTI.

Information on the Nine Mile Point Power Reactor is given under the following broad topics: Introduction; Summary; Important Safety Considerations; Accident Analysis; Development of Final Design; Technical Qualifications; Report to the Advisory Committee on Reactor Safeguards; and Conclusions. (D.C.C.)

15537 (DOCKET-50244-14) ROBERT EMMETT GINNA NUCLEAR POWER PLANT, UNIT NO. 1. Final Facility Description and Safety Analysis Report, Amendment 14, Suppl. 8, Exhibit D-12. (Rochester Gas and Electric Corp., N. Y.). Feb. 5, 1969. 137p. Dep. CFSTI.

Complete Technical Specifications are included for the Robert E. Ginna Power Reactor Unit 1. Bases for the Technical Specifications are given, also. (M.L.S.)

15538 (DOCKET-50244-15) ROBERT EMMETT GINNA NUCLEAR POWER PLANT, UNIT NO. 1. Final Facility Description and Safety Analysis Report, Amendment 15, Suppl. 9, Exhibit D-13. (Rochester Gas and Electric Corp., N. Y.). Feb. 7, 1969. 198p. Dep. CFSTI.

Additional or revised information for the Robert E. Ginna Power Reactor, Unit 1 is given on the following broad topics: Introduction and Summary; Reactor; Reactor Coolant System; Containment; Engineered Safeguards; Instrumentation and Control Systems; Electrical Systems; Conduct of Operations; and Safety Analyses. (M.L.S.)

15539 (DOCKET-50244-16) ROBERT EMMETT GINNA NUCLEAR POWER PLANT, UNIT NO. 1. Final Facility Description and Safety Analysis Report, Amendment 16, Suppl. 10, Exhibit D-14. (Rochester Gas and Electric Corp., N. Y.). Feb. 20, 1969. 113p. Dep. CFSTI.

Revised information on Robert E. Ginna Power Reactor, Unit 1 is given on: reactor integrals design, steam generator design, leakage limitations for the cooling system, testing of the cooling system after opening, containment vessel design and missile protection, effects of loss of air to air-operated valves, results of coolant loss simulation tests on safety injection system cabling, seismic design requirements for the control room and containment and auxiliary building, physical isolation and identification of wirings, feedwater and steam flow, safeguards-initiating circuitry, boric acid tank liquid level system, reactor coolant radionuclide inventory, activity limits for gaseous and liquid waste disposal systems, and effects of calculated iodine release rates on thyroid dose. (M.L.S.)

15540 (DOCKET-50255-13) PALISADES PLANT. TECHNICAL SPECIFICATIONS. Final Safety Analysis Report, Amendment 10. (Consumers Power Co., Jackson, Mich.). Jan. 31, 1969. 104p. Dep. CFSTI.

Information on the Palisades Power Reactor is given under the following broad topics: Design Features; Safety Limits and Maximum Safety Settings; Limiting Conditions for Operation; Surveillance Requirements; and Administrative Controls. (D.C.C.)

15541 (DOCKET-50317-10) CALVERT CLIFFS NUCLEAR POWER PLANT, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 7. (Baltimore Gas Electric Co., Md.). Feb. 3, 1969. 64p. (DOCKET-50318-10). Dep. CFSTI.

Updated financial data on Baltimore Gas and Electric, owners of Calvert Cliffs Power Reactor, Units 1 and 2, are given. Revised wind and tornado force design loads are listed; concrete and steel prestressing tendon materials are described. The splicing of reinforcing bars by the Cadweld process is discussed; joint testing and acceptance standards are given. Liquid waste discharge from the site is detailed; yearly average discharge is tabulated as a function of isotope. Off-site consequences of a steam line rupture are discussed relative to secondary system activity. (M.L.S.)

15542 (DOCKET-50319-7) BELL STATION. Preliminary Safety Analysis Report, Amendment 3. (New York State Electric and Gas Corp., Binghamton). Jan. 31, 1969. 356p. Dep. CFSTI.

Detailed information on the operation of the Bell Power Reactor is given. Effects of an unintentional spill of stored radwaste on the lake nearby are detailed; buildup of radioactivity in the lake over a ten year period is analysed. Mathematical models for radwaste effects are given; data are tabulated. The pre- and post-operational environmental monitoring programs are described. Materials for reactor core and internals are discussed. Design information for the primary containment system is detailed; design criteria for large penetrations are discussed. Containment vessel liner design is described. Independence of control rod position displays are evaluated; a schematic of rod

drift circuitry is shown. Trip and bypass circuits for operations instrumentation are discussed. Independence of redundant emergency buses is evaluated; off site power supply to emergency buses is shown by diagrams. The quality assurance program for the whole plant is detailed. (M.L.S.)

15543 (DOCKET-50321-6) EDWIN I. HATCH NUCLEAR PLANT, UNIT 1. Preliminary Safety Analysis Report, Amendment 2. (Georgia Power Co., Atlanta). Jan. 30, 1969. 450p. Dep. CFSTI.

Effects of boiling water reactor dynamic loadings on fracture toughness of core and internal materials is applied to Edwin I. Hatch Power Reactor, Unit 1 design. Design bases for sizing the safety and relief valves are given; relief and safety valve capacity are discussed. Coolant flow, depressurization, and core cooling are evaluated for a steam line break accident; the steam line break accident is compared to a pump trip transient. In-service inspection of the primary cooling system is discussed; schedules and methods to be used are listed. Secondary containment penetrations are tabulated; possible leakage is estimated; the standby gas treatment system is described. Design details are given for the containment systems. Emergency Core Cooling Systems (ECCS) actuation, capability, and design is discussed. Peak cladding temperatures are shown as a function of break area for each member of the ECCS operating and for the entire ECCS operation; the design of the liquid poison injection system is discussed. Adequacy of the design of the reactor protective system is evaluated. Procedures for shutdown of the reactor to cold conditions from outside the reactor control room are given. Radionuclide content of liquid and gaseous effluent is tabulated. Tornado protection of the spent fuel storage area is detailed. Detailed information on seismic classifications and analyses for buildings and structures is given. (M.L.S.)

15544 (DOCKET-50324-7) BRUNSWICK STEAM ELECTRIC PLANT, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 5. (Carolina Power and Light Co., Raleigh, N. C.). Feb. 3, 1969. 133p. (DOCKET-50325-7). Dep. CFSTI.

Revised information on Brunswick Power Reactor, Units 1 and 2, is given on the following topics: Introduction and Summary; Electrical Systems; Plant Operations; station seismic design criteria, and missiles from distant explosions. (M.L.S.)

15545 (DOCKET-50324-8) BRUNSWICK STEAM ELECTRIC PLANT, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 4, Suppl. 3. (Carolina Power and Light Co., Raleigh, N. C.). Feb. 3, 1969. 650p. (DOCKET-50325-8). Dep. CFSTI.

General information relating to the Brunswick Power Reactor, Units 1 and 2, is given. Effects of accidental spillage of radioactive wastes into the groundwater are evaluated; the bedrock investigations for the Brunswick site are detailed; bedrock boring data are included. Topographic and geologic characteristics of the area are analysed; soils characteristics and stability data are described. Maximum probable hurricane tide elevation at the plant intake and discharge canal is analysed. Area development and land usage are discussed. Details pertaining to fuel element design are given. Leak detection methods for the primary system are described; design provisions for the components of the coolant boundary are compared to General Design Criterion 35. Seismic design criteria for reactor intervals and Class I equipment and piping systems are given. The instrumentation program for structural testing is described. The control rod position indicating system for the Brunswick reactors is discussed. Fuel element failure detection methods are outlined. The Select Rod Insert System is described. Main scram line isolation valve closures which initiate a scram are given. Installation of power, control, and instrumentation wiring is discussed; criteria and bases for installation are outlined. The maximum inventory of radionuclides in the radwaste system is tabulated; planned releases of radioactive material are described. Proposed staffing requirements for the dual plant facility are given; operating crew requirements are analysed. Preoperational and startup tests are described. The results of $\frac{1}{4}$ scale pressure suppression tests with multiple vents are included. (M.L.S.)

15546 (DOCKET-50327-4) SEQUOYAH NUCLEAR PLANT, [UNITS 1 AND 2]. Preliminary Safety Analysis Report, Amendment 1. (Tennessee Valley Authority, [Knoxville]). Jan. 17, 1969. 439p. (DOCKET-50328-4). Dep. CFSTI.

Revised information is given on Sequoyah Power Reactor, Units 1 and 2. Revised pages are included for the following PSAR sections: Introduction and Summary; Site and Environs; Reactor; Reactor Cooling System; Containment; Engineered Safeguards; Instrumentation and Control; Electrical Systems; Auxiliary and Emergency Systems; Steam and Power Conversion Systems; Waste Disposal and Radiation Protection; and Safety Analyses. (M.L.S.)

15547 (DOCKET-50329-4) [MIDLAND PLANT, UNITS 1 AND 2]. [Preliminary Safety Analysis Report], Amendment 1. (Consumers Power Co., Jackson, Mich.). Feb. 3, 1969. 59p. (DOCKET-50330-4). Dep. CFSTI.

The soils investigations for the site for the Midland Power Reactor, Units 1 and 2, are given. Results of field explorations and laboratory tests are included. (M.L.S.)

15548 (DOCKET-50335-1) HUTCHINSON ISLAND PLANT, UNIT NO. 1. Preliminary Safety Analysis Report, Vol. 1. (Florida Power and Light Co.). Jan. 29, 1969. 315p. Dep. CFSTI.

Information on Hutchinson Island Power Reactor, Unit 1 is given on the following broad topics: Introduction and Summary; Site and Environment; and Reactor. (M.L.S.)

15549 (DOCKET-50335-2) HUTCHINSON ISLAND PLANT, UNIT NO. 1. Preliminary Safety Analysis Report, Vol. 2. (Florida Power and Light Co.). Jan. 29, 1969. 425p. Dep. CFSTI.

Information on Hutchinson Island Power Reactor, Unit 1 is given under the following broad topics: Reactor Coolant System; Containment System; Engineered Safeguards; Instrumentation and Control; Electrical Systems; Auxiliary Systems; Steam and Power Conversion System; Waste Management and Radiation Protection; Conduct of Operations; Initial Tests and Operations; and Safety Analysis. (M.L.S.)

15550 (DOCKET-50335-3) HUTCHINSON ISLAND PLANT, UNIT NO. 1. Preliminary Safety Analysis Report, Vol. 3. (Florida Power and Light Co.). Jan. 29, 1969. 249p. Dep. CFSTI.

Detailed results of the soil investigation for the Hutchinson Island Power Reactor, Unit 1 are given. Data are included on triaxial shear testing, cyclic triaxial shear testing, consolidation testing, relative density determinations, permeability testing, shear strength data summary, water contents and densities of undisturbed and split-spoon samples, grain size determination, and boring logs. (M.L.S.)

15551 (DUN-SA-74) DECONTAMINATION OF N-REACTOR STAINLESS STEEL STEAM GENERATORS. Bainard, W. D. (Douglas United Nuclear, Inc., Richland, Wash.). Nov. 11, 1968. 11p. (CONF-690304-1). Dep. CFSTI.

From 25th Annual Conference of the National Association of Corrosion Engineers, Houston, Tex.

Decontamination processes and solutions used on the N-reactor Type-304 stainless steel-tubed steam generators to remove the radioactive corrosion film prior to returing are presented. (H.D.R.)

15552 (EUR-4089) GARIGLIANO NUCLEAR POWER PLANT. Annual Report, 1967. (Ente Nazionale per l'Energia Elettrica, Rome (Italy)). Aug. 23, 1968. Contract 003-61-12 REPI. 106p. (In Italian). Dep.

Operations during March 1, 1967, through February 29, 1968, for the Garigliano Power Plant are described. The availability and utilization factors attained the same values throughout almost all this period, so that the lack of demand and the non-availability of the grid had a limited influence on output. Outage due to the "conventional" parts, imputable to a large extent to preheater and condenser leakages was high, reaching a maximum of about 30% in November; the "nuclear" non-availability was 3% in March 1967 and 7% in April, owing to the gradual loss of available reactivity. From May 7 to August 1 the plant was shut down in order to carry out general maintenance work, overhaul the turbine (reassembly of the 20th stage), and also in order to replace the 48 stainless-steel channels still present in the core by a similar number of Zircaloy channels and to charge the reactor with 14 new fuel elements and five partially irradiated elements. Detailed information on the chemical and radiological situation in the plant is presented. (auth)

15553 (GA-9016) PRESTRESSED CONCRETE PRESSURE VESSELS. Arthur, Ian P. (Gulf General Atomic, Inc., San Diego, Calif.). Oct. 30, 1968. Contract AT(04-3)-633. 19p. (CONF-690307-1). Dep. CFSTI.

From Advances in High-Pressure Technology Symposium, New Orleans, La.

The design of the first prestressed-concrete reactor vessel in the United States, now under construction, is described. Extensive developmental work was carried out by Gulf General Atomic Incorporated in support of the design and construction of this vessel. Prestressed concrete vessels are now being designed for reactors up to 1,200 MW(e) in size. (auth)

15554 (GAMD-8703) PEACH BOTTOM 150 FULL-POWER DAY CORE EXAMINATIONS. Results of Peach Bottom Post-

construction R and D Test Procedures JM-2, JM-3, JM-4, and JM-6. Scheffel, W. J.; Brown, J. R.; Disselhorst, B. F.; Wallace, W. P. (Gulf General Atomic, Inc., San Diego, Calif.). Dec. 31, 1968. Contract AT(04-3)-314. 70p. Dep. CFSTI.

The reactor was shut down on January 11, 1968 for the purpose of conducting visual and gamma scan examinations. At that time the reactor had attained approximately 168 equivalent full-power days of operation. The first Peach Bottom "150 equivalent full-power day" core examinations were performed after 168 equivalent full-power days (EFPD) of operation during the month of February 1968. These examinations are required during the first 900 EFPD of Peach Bottom operation by the plant Technical Specifications and were carried out under the Peach Bottom Postconstruction Research and Development Program, utilizing test procedures JM-2, JM-3, JM-4, and JM-6. Fuel elements B13-05 and B13-07 were examined and γ scanned. Reflector elements A17-16 and B18-12 were examined. All of the control rod and emergency shutdown rod guide tube caps were visually examined. The results of the in-vessel examinations indicate that the Peach Bottom fuel elements, reflector elements, and control rod and emergency shutdown rod guide tubes have demonstrated very good stability after 168 full-power days of operation. No detrimental irradiation effects were observed on any of the components examined in these tests. The measured fuel compact column axial expansions were small and within the range anticipated. (auth)

15555 (HN-193) CLASSIFICATION AND PROCESSING OF RELIABILITY DATA FROM NUCLEAR POWER PLANTS. Garrick, B. J.; Gekler, W. C.; Baldonado, O. C.; Behrens, E. H.; Shimizu, B. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Feb. 1968. Contract AT(10-1)-205; Subcontracts C-275; C-623. 192p. Dep. CFSTI.

For Holmes and Narver, Inc., Los Angeles, Calif.

Methods for classifying and processing reliability data to a point suitable for use in a working data collection program have been developed. The classification codes are scoped primarily to accommodate the designs and components found in engineered safety systems. Particular emphasis has been given to ensure overall compatibility by liaison with the CHORD-S program and the LMRC program. The needs of each program are reviewed and where possible standard formats are derived for data classification. While complete standardization seems inadvisable at this point, areas amenable to some standardization are report date and time, repair time, data and time of recovery from failure as well as a component/part classification code consisting of one to six descriptor variables, and codes for describing the mode, cause, and effect of failure. An operating data reduction program, FAILDARE, is presented for calculation of reliability data from operating experience accumulated and classified according to the classification code. FAILDARE has been written in FORTRAN IV language and is operable on machines capable of IBM 7094 computer mode processing. The usefulness of FAILDARE is demonstrated by examples of processed output data derived from experience accumulated at the CVTR facility. (auth)

15556 (SWRI-1228-P-11-1) SURVEILLANCE AND INSPECTION PROGRAMS FOR LACBWR REACTOR PRESSURE VESSEL AND ASSOCIATED PIPING AND EQUIPMENT VISUAL INSPECTION SYSTEM STUDY. Topical Report No. 1. Hendricks, H. E. (Southwest Research Inst., San Antonio, Tex.). Mar. 5, 1968. Contract AT(11-1)-1228. 20p. Dep. CFSTI.

It is proposed that a compact radiation-resistant closed circuit television system be used for visually inspecting the reactor and supporting systems where radiation and/or space limitations do not permit direct viewing. The radiation tolerant system would consist of a COHU 2500 series camera modified for underwater use, two lenses (a ½-inch and a 3-inch), a pre-amp, camera control unit, lens control, monitor, a custom built right-angle viewing unit, lights, a pan and tilt mechanism, supporting device and necessary cables. The television camera and right-angle viewing unit are capable of passing through the 3.875-inch holes in the reactor upper grid plate. With proper lighting and lens selection, the television system would perform general visual inspections and also be capable of viewing cracks 0.003 inch wide or greater. Resolution would be limited by a 525 line scanning pattern which results in horizontal resolution in excess of 600 horizontal lines on the vidicon. The system is powered by 110V AC 60 cycles. Its total cost is estimated to be $13,790.00. (auth)

15557 (SWRI-1228-P-11-2) SURVEILLANCE AND INSPECTION PROGRAMS FOR LACBWR REACTOR PRESSURE VESSEL AND ASSOCIATED PIPING AND EQUIPMENT CORROSION PROGRAM. Topical Report No. 2. (Southwest Research Inst., San Antonio, Tex.). Apr. 11, 1968. Contract AT(11-1)-1228. 25p. Dep. CFSTI.

The program has been set up to determine corrosion rates of the forced-circulation piping system using corrosion coupons and ultrasonic measurements. All previous work concerning corrosion specimen fabrication, weighing, and installation is summarized. Initial ultrasonic thickness measurements of several selected locations in the forced-circulation system are described and recorded. (auth)

15558 (WAPD-MRP-126) PRESSURIZED WATER REACTOR (PWR) PROJECT. Technical Progress Report, July 27-October 25, 1968. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Contract AT(11-1)-Gen-14. 38p. Dep. CFSTI.

A total of 12,670 EFPH was accumulated on PWR Core 2 Seed 1 at Shippingport through October 25, 1968. The reactor was shutdown on two occasions during the report period for instrumentation changes and to return the plant from three to four coolant loop operation. The PWR Core 2 Seed 2 power capability for full power equilibrium xenon operation was evaluated based on fuel element considerations. Destructive evaluations were conducted on Core 2 Seed 2 fuel plates and on Core 1 blanket rods removed at the end of Seed 4. (H.D.R.)

15559 (WCAP-3269-66) COMPARISON OF PREDICTED AND MEASURED NUCLEAR DESIGN PARAMETERS AT BEGINNING OF LIFE OF CYCLE 1 IN THE SAN ONOFRE REACTOR. Impink, Albert J. Jr.; Easter, James R.; Leggett III, W. D. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). [nd]. Contract AT(30-1)-3269. 146p. Dep. CFSTI.

A program of reactor physics tests has been carried out at beginning-of-life of the first fuel cycle in the San Onofre Nuclear Generating Station in support of the nuclear design effort which preceded construction and operation of the station. Final design methods and analytically derived predictions are reviewed and the results of the experimental program, spanning reactor operations from first criticality to initial operation at 395 MW(e), are presented. Finally, comparison is made between predicted and measured values and conclusions concerning the validity of the analytical procedures are drawn. (auth)

15560 CIRCUIT MAKERS NEED SUPERVISION. Stephens, J. V. Power Eng., 73: 33-5(Feb. 1969).

The supervision procedures and equipment for circuit breakers used in nuclear power reactors are described. The requirements of supervision to meet reactor safeguards are analyzed. (D.C.C.)

15561 HEUTIGER STAND UND TENDENZEN IN DER ENTWICKLUNG VON REAKTOREN. ZWEITE REAKTORTAGUNG, ESSEN, VOM 5. DEZEMBER 1967. (Present State and Trends in Reactor Development. Second Reactor Meeting, Essen, December 5, 1967). Schulten, R. (ed.). Haus der Technik-Vortragsveroeffentlichungen, Heft 162. Essen, Vulkan-Verlag Dr. W. Classen, 1968. 93p. DM 28.-. (CONF-671218).

Included are 7 papers on operating experience, economics, safety, and development trends for nuclear power reactors. Separate abstracts were prepared for each paper. (H.D.R.)

For abstracts of individual papers see: 15562-15566, 15609, and 15651.

15562 HIGH TEMPERATURE REACTORS WITH HELIUM TURBINES. Boehm, Edgar (Gutehoffnungshuette AG, Oberhausen, Ger.). pp 58-69 of Heutiger Stand und Tendenzen in der Entwicklung von Reaktoren. Schulten, R. (ed.). Essen, Vulkan-Verlag Dr. W. Classen, 1968. (In German).

From 2nd Reactor Meeting: Present State and Trends in Reactor Development, Essen, Germany. See CONF-671218.

A typical primary circuit for a nuclear power plant using helium turbines and engineering features of a 25 MW(e) plant are described. Construction features of 100 and 600 MW(e) turbines are illustrated, and performance criteria of a 1000 MW(e) nuclear plant with a high temperature reactor and gas turbines are tabulated. (H.D.R.)

15563 THE PROGRESS OF GAS-COOLED REACTORS (AGR), THEIR GOOD POINTS AND POSSIBLE FUTURE. Marnet, Chrysanth (Brown, Boveri and Cie AG, Mannheim, Ger.). pp 45-57 of Heutiger Stand und Tendenzen in der Entwicklung von Reaktoren. Schulten, R. (ed.). Essen, Vulkan-Verlag Dr. W. Classen, 1968. (In German).

From 2nd Reactor Meeting: Present State and Trends in Reactor Development, Essen, Germany. See CONF-671218.

Power reactors of the AGR-type are described, and some engineering and performance characteristics of 600 MW(e) and 1500 MW(t) are presented. Cost data on gas-cooled power reactors are examined. (H.D.R.)

15564 MODERN NUCLEAR POWER PLANTS WITH BOILING WATER REACTORS IN AREAS WITH HIGHER POPULATION DENSITY. Traube, Klaus (AEG-Telefunken, Frankfurt am Main). pp 33-44 of Heutiger Stand und Tendenzen in der Ent-

wicklung von Reaktoren. Schulten, R. (ed.). Essen, Vulkan-Verlag Dr. W. Classen, 1968. (In German).

From 2nd Reactor Meeting: Present State and Trends in Reactor Development, Essen, Germany. See CONF-671218.

Containment criteria for large modern boiling water reactors and their effects on site selection are examined. The primary circuit, waste gas activity, building layout, control circuit, pressure history in the containment following an accident, and the emergency cooling, flooding, and spray systems are described for a typical 600 MW(e) reactor. (H.D.R.)

15565 PRESSURIZED-WATER REACTORS, PROGRESS AND POSSIBLE DEVELOPMENTS. Martin, Arno (Siemens-Schuckertwerke AG, Erlangen, Ger.). pp 19-32 of Heutiger Stand und Tendenzen in der Entwicklung von Reaktoren. Schulten, R. (ed.). Essen, Vulkan-Verlag Dr. W. Classen, 1968. (In German).

From 2nd Reactor Meeting: Present State and Trends in Reactor Development, Essen, Germany. See CONF-671218.

Developments in pressurized water power reactors are examined by comparing specifications and performance data for their 15 year history. Fuel element fabrication and performance, thermodynamic performance, pressure vessel and containment design and fabrication, and cooling circuit performance are discussed. (H.D.R.)

15566 MANAGEMENT PRACTICES WITH NUCLEAR POWER PLANTS. Weckesser, August (Kernkraftwerk RWE-Bayernwerk GmbH, Gundremmingen, Ger.). pp 5-18 of Heutiger Stand und Tendenzen in der Entwicklung von Reaktoren. Schulten, R. (ed.). Essen, Vulkan-Verlag Dr. W. Classen, 1968. (In German).

From 2nd Reactor Meeting: Present State and Trends in Reactor Development, Essen, Germany. See CONF-671218.

Operating experience with U.S. and West European power reactors through 1966 is summarized. Representative examples of the three principle reactor types—gas-cooled, boiling water, and pressurized water—are described, and their performance history is summarized. (H.D.R.)

15567 NUCLEAR POWER: SUDDENLY HERE. Shaw, Milton; Whitman, Merrill. Sci. Technol. (N. Y.), No. 75, 22-34 (Mar. 1968).

Over the next 6 yr the utilities are presently committed to starting up 61 new nuclear plants. Though none of the plants now in use has a capacity greater than 500 MW(e), more than 50 of the plants on order will exceed this capacity, and 14 are expected to exceed 1000 MW(e). The AEC is now concentrating on developing more advanced reactor types that would economically convert nonfissionable material into fissionable material that could either be recycled or used to fuel new reactors. Most of these advanced systems will also produce higher steam temperature than the light-water reactors and thus permit the plants to operate more efficiently. Advanced reactor concepts currently remaining in favor include the high-temperature gas-cooled reactor, the heavy-water moderated reactor, and the thermal and fast breeders. The operation of these is discussed. (BBB)

15568 RECENTLY REPORTED OCCURRENCES OF NUCLEAR-SAFETY-RELATED SIGNIFICANCE. Cramer, E. N. (comp.). Nucl. Safety, 10: 175-8 (Mar.-Apr. 1969).

A compilation of safety-related occurrences is given. The following occurrences are described: use of liquid-penetrant bleed-out volume to detect deep cracks in Oyster Creek-1 pressure vessel; tubing-fitting failure in N. S. Savannah; reflector flooding effects on neutron monitoring channels in Texas A and M TRIGA; and plugging of injection pumps by boric acid crystals at San Onofre. (15 references) (M.L.S.)

15569 PEACH BOTTOM 1 EXPERIENCE WITH INERT CONTAINMENT ATMOSPHERE OBTAINED BY BURNING PROPANE IN AIR. Knapp, W. J.; Cooney, M. J. Nucl. Safety, 10: 171-5 (Mar.-Apr. 1969).

The initial design for obtaining inert gas for the Peach Bottom I containment atmosphere proved to be undesirable for two reasons. The gas was derived from the combustion of propane, and small amounts of chemical contaminants caused corrosive attack on metal surfaces and instrumentation; also, poor reliability of the system and the required frequent maintenance would probably have resulted in frequent plant shutdown to keep within technical-specification requirements. A temporary substitute system that utilized vaporized liquid nitrogen was in service for almost 2 years, and a permanent version of that system was installed in the summer of 1968. Although this system has higher operating costs, a noncorrosive and highly reliable system has been achieved. (auth)

15570 ACTION ON REACTOR AND OTHER PROJECTS UNDERGOING REGULATORY REVIEW OR CONSIDERATION. Blakely, J. P. (comp.). Nucl. Safety, 10: 188-96 (Mar.-Apr. 1969).

USAEC regulatory action is summarized for: Duane Arnold (Docket 50-331), Barnwell Nuclear Fuel Plant (Docket 50-322), Maine Yankee (Docket 50-309), Monticello (Docket 50-263), Pathfinder (Docket 50-130), Rancho Seco (Docket 50-312), SEFOR (Docket 50-231), Sequoyah 1 and 2 (Dockets 50-327 and 50-328), and Zion 1 and 2 (Dockets 50-295 and 50-304). (11 references) (M.L.S.)

15571 ON THE OUT-OF-PILE TEST OF MAGNOX FUEL ELEMENTS CONSTRUCTED IN TRIAL. Kawashima, Kiichi (Furukawa Electric Co., Ltd., Japan). FAPIG (Tokyo), No. 50, 111-14 (Aug. 1968). (In Japanese).

A series of studies have been made on Magnox fuel elements for the JAPC Tokai power station. As a part of this series, out-of-pile tests were carried out on the performance and integrity of such fuel elements constructed in trial, under the reactor conditions. The tests included the thermal cycle tests of both large and small amplitudes in the high gas temperature and high pressure. Using an experimental, high temperature gas loop the fuel elements of the size of the Tokai power station were also tested. The results of the tests as well as the fuel elements and the tests performed are described. (NSA of Japan)

15572 FUKUSHIMA NUCLEAR POWER STATION UNIT NO. 1, TOKYO ELECTRIC POWER CO. Hada, Mikio (Tokyo Shibaura Electric Co., Ltd.); Sazawa, Kunito. Toshiba Rebyu, 24: 13-21 (Jan. 1969). (In Japanese).

The Tokyo Electric Power Co. is now constructing its first nuclear power station at Futaba site in Fukushima Prefecture. The General Electric Co. who had developed the boiling water reactor was selected as the supplier of the complete plant equipment on the basis of the "turnkey" contract. Toshiba is one of the major subcontractors to supply the reactor pressure vessel, reactor internals, reactor system equipment, etc. The power station is the largest among the nuclear power stations either in operation or under construction in this country. It is expected to be completed in 1969. Briefly summarized are the outlines of the station, introduction of major equipment, and present status of the pressure vessel and internals. (NSA of Japan)

15573 U. K.: A DEFEAT FOR COAL. Mining J. (London), 271: 143 (Aug. 30, 1968).

The U. K. has chosen nuclear power for a new power station to be built at Hartlepool which should be operating in 1973. The construction cost will be £91 million, and the total cost including interest charges during construction and the initial charge for the nuclear fuel will be £125 million. Of 1,250-MW capacity, the station will be of the advanced gas-cooled type and will be the third after Dungeness B and Hinckley B in the Central Electricity Generating Board's A. G. R. program. With the Hunterston B A. G. R. station in Scotland, these stations will provide an aggregate capacity of 5,000 MW towards the total of 8,000 MW laid down in the government's Second Nuclear Power Program for the 1970's. The cost per unit of electricity from the nuclear station will be 0.52d, against 0.70d from a coal station, assuming a 75% load factor in each case. For a nuclear station, 0.36d of the total 0.52d per unit is accounted for by capital charges, and the remainder is operating costs. (BBB)

15574 NUCLEAR POWER GENERATION WHICH ATTAINED TO THE TIME OF PRACTICAL USE. Nippon Gasu Kyokaishi, 21: No. 1, 23-7 (Jan. 1968). (In Japanese).

More than 10 years elapsed since the start of nuclear energy development in Japan, and the Tokai power plant of the Japan Atomic Power Co. with 166 MW output started its commercial operation. The contemplated nuclear power generation amounted to 6 million kW in 1975 and 40 million kW in 1985. The Power Reactor and Nuclear Fuel Development Corp. is carrying forward the project of self development of the new type conversion reactor and the fast breeder reactor. The economic growth in Japan is spectacular, and the demand for electric power is expected to reach at 256 billion kWH in 1970 and 396 billion kWH in 1975. The atomic energy produces a very large amounts of energy per unit weight, its fuel cost per generated energy is cheap, and the supply of energy bearing material is stable. The development of nuclear power generation results in the saving of heavy fuel oil, and contributes to the balance of international payment. Assuming the nuclear power output in 2000 is 164.45 million kW, the required amount of nuclear fuel is about 20,000 tons of natural uranium by conversion, and it is superior in the fields of transport and store of fuel. The generating cost of nuclear power is fairly hopeful to compete with the oil firing power generation. The technical and economic developments of nuclear power generation in U. S. A. and Great Britain, the nuclear power generation programs of Japanese power companies, the plan of securing

nuclear fuel, and the development program of power reactors in Japan are described. (NSA of Japan)

15575 OPERATING EXPERIENCE AND PROSPECTS OF DEVELOPMENT OF NUCLEAR STATIONS IN ITALY. Angelini, A. M.; Sani, L. (ENEL, Rome). Energ. Nucl. (Milan), 16: No. 2, 1-9(Feb. 1969).

The present situation of nuclear power stations in Italy and the basic reasons for the launching of a new Italian program are presented. The most significant facts of the valuable experience acquired with the operation of ENEL's three nuclear power stations are described. The provisions which the manufacturers have adopted in order to increase the reliability of the nuclear stations in operation and specifically of those to be commissioned in the near future are included. After indicating the course followed by ENEL for the fourth nuclear power station, the present forecasts on nuclear power development in Italy are presented. (5 references) (auth)

15576 ATOMIC POWER PLANT WITH TWO 440 MW(e) REACTORS. Stekol'nikov, V. V.; Sidorenko, V. A.; Tatarnikov, V. P.; Yazvenko, B. S.; Denisov, V. P. At. Energ. (USSR), 25: 408-16(Nov. 1968). (In Russian).

Each reactor has an electrical power of 440 megawatts and a thermal power of 1370 megawatts. Vapor pressure of steam in the first cycle is 125 kg/cm^2 which falls to 47 kg/cm^2 in the second cycle. This second cycle steam is fed to two turbines at a rate of 39,000 m^3/hr. The average exit steam temperature is 300°C, and the inlet temperature is 270°C. The fuel elements consist of 3.3% enriched UO_2 clad with a Zr alloy. Details are given on the control system, arrangement of the vessels, shielding, thermal reactor parameters, reactor tank, neutron distribution, control of reactivity, circulating pumps and turbine characteristics. (TTT)

15577 ATOMIC POWER PLANT WITH THE BN-600 REACTOR. Leipunskii, A. I.; Afrikantov, I. I.; Golovnin, I. S.; Mitenkov, F. M.; Orlov, V. V.; Pinkhasik, M. S.; Rineiskii, A. A.; Stekol'nikov, V. V.; Troyanov, M. F.; Shiryaev, V. I. At. Energ. (USSR), 25: 403-8(Nov. 1968). (In Russian).

The BN-600 reactor is an outgrowth of the experience obtained in operating a series of five, fast neutron reactors (BP-1 to BP-5), and the BN-350 power reactor. The BN-600 reactor has a thermal power of 1430 megawatts, and an electrical power of 600 megawatts. The flow rate of sodium metal coolant through the reactor is 24,000 tons/hr. At 100% power the sodium metal inlet temperature is 375 to 410°C, and the outlet temperature is 545 to 580°C. The reactor produces vapor at a rate of 1836 tons/hr with an exit vapor temperature of 505 to 540°C and a vapor pressure of 140 kg/cm^2. The maximum burnup is 10%, and the time between loadings is ~150 days. The fuel elements consist of uranium oxide or a mixture of uranium and plutonium oxides clad in stainless steel. The core is surrounded with a breeding zone filled with briquettes of depleted uranium. The control system and arrangement of fuel rods are described. (TTT)

15578 SAFETY AND SITING OF NUCLEAR POWER STATIONS IN THE UNITED KINGDOM. Griffiths, Trevor (Ministry of Power, London). Tek. Vetensk. Forsk., 39: 265-71(1968).

The existing and planned nuclear power stations in the U. K. are presented. Implications of a new safety and siting policy are reviewed which permits reactors of the advanced gas-cooled type in a prestressed concrete pressure vessel to be sited nearer to population centers. The following problems are discussed: siting (weighting population with distance); design manufacture and construction; operation. The conclusion is that the greatest contribution to safety is made by standards of design, construction and operation. (auth) (Sweden)

15579 THE PRESENT SITUATION OF TOKAI POWER PLANT. Asada, Chuichi Karyoku Hatsuden, 19: 841-7(Aug. 1968). (In Japanese).

In Tokai power plant, imported from Great Britain and constructed by the Japan Atomic Power Co., reached criticality on May 4, 1965, and the first power was generated successfully on Nov. 10, 1965. Since then the troubles occurred in succession, and the testing period was extended unexpectedly long, but on July 24, 1967, the continuous operation at the rated output of 166,000 kW was approved. Since the test of the fuel replacing machine at the loaded conditon was not yet completed, the condition that replacing of fuel should be carried out in the no load condition or in stoppage of the reactor was attached. Operations and performance from 1965 to 1968 are described. (NSA of Japan)

15580 STATUS OF IN-CORE MONITORS DEVELOPMENT. Hashimoto, Hiroshi; Shirayama, Shimpey (Tokyo Shibaura Electric Co., Ltd.). Genshiryoku Kogyo, 14: 47-53(Oct. 1968). (In Japanese).

In the recent BWR plants with increased output, it is necessary to monitor neutron fluxes in the core accurately. This promoted the research and development on in-core monitors. In this field, G.E. in the United States is in the foremost position; in Japan, Tokyo Shibaura Elect. Co., Ltd., has pursued their development, already succeeding in the manufacturing. The present state of development of in-core monitors is described in the following: usefulness of the in-core monitors; neutron-measuring instrumentation in BWR plants (source range, intermediate range and power range monitors); construction and operation of the in-core monitors; and performance of the in-core monitors. (NSA of Japan)

15581 FUKUSHIMA NUCLEAR POWER STATION UNIT NO. II, TOKYO ELECTRIC POWER CO. Inaba, Eiji; Kani, Jiro (Tokyo Shibaura Electric Co., Ltd.). Toshiba Rebyu, 24: 22-5 (Jan. 1969). (In Japanese).

Construction of Tsuruga Power Station of the Japan Atomic Power Co. and Fukushima Power Station Unit No. I of the Tokyo Electric Power Co. is described. The plants now being developed are to be built with many improved phases due to recent technological progress. Fukushima Power Station Unit No. II, intended to commence commercial operation in May 1973, has an electric output of 783,913 kW, the largest within the country; the reactor is the G. E. standard BWR with high power density and improved core average burnup; thus the unit is to be improved in safety, reliability and economy. (NSA of Japan)

15582 THE NUCLEAR POWER PLANT OBRIGHEIM: FROM PLANNING TO STARTUP. Schenk, H. (Technischer Geschaeftsfuehrer, Obrigheim, Ger.). Atomwirt., Atomtech., 13: 594-5 (Dec. 1968). (In German).

The Obrigheim nuclear power station has a pressurized water reactor with a guaranteed net output of 283 MW(e). Total investment costs amounted to DM 270 million and the initial fuel charge cost DM 58 million. The construction license was applied for on July 16, 1964, and the reactor achieved initial criticality on September 22, 1968. (H.D.R.)

15583 A GENERAL VIEW OF CONSTRUCTION OF THE KWO. Lepie, G.; Martin, A. (Siemens AG, Erlangen, Ger.). Atomwirt., Atomtech., 13: 596-606(Dec. 1968). (In German).

The Obrigheim site, plant layout, reactor cooling system, reactor building, reactor core, pressure vessel, fuel elements, steam power plant, electrical plant, and control setup are described. Technical data on the reactor and steam power plant are tabulated. (H.D.R.)

15584 OPERATIONS PROGRAM OF THE KWO UP TO FIRST CRITICALITY. Breitwieser, W.; Kirchweger, K.; Martin, A.; Wegmann, A. (Siemens AG, Erlangen, Ger.). Atomwirt., Atomtech., 13: 607-12(Dec. 1968). (In German).

The installation and testing of the Obrigheim primary systems and components are described. (H.D.R.)

15585 NEUTRON PHYSICS RESEARCH DURING OPERATION OF THE KWO. Bronner, G.; Dio, W.-H.; Etzel, W.; Gruen, A. E.; Pfeiffer, R. (Siemens AG, Erlangen, Ger.). Atomwirt., Atomtech., 13: 618-20(Dec. 1968). (In German).

The Obrigheim reactor achieved initial criticality on September 22, 1968. The zero power test program which was conducted to confirm the core kinetics calculations is described. (H.D.R.)

15586 TRANSPORT AND LOADING OF THE FUEL ELEMENTS. Krueger, J.; Schubert, F. (Siemens AG, Erlangen, Ger.). Atomwirt., Atomtech., 13: 620-1(Dec. 1968). (In German).

The procedures and containers used for transport of the Obrigheim fuel elements, and the loading sequence for the first core are described. (H.D.R.)

15587 CORROSION AND PURIFICATION CONTROL IN THE KWO PRIMARY SYSTEM. Schweigert, F. (Siemens AG, Erlangen, Ger.). Atomwirt., Atomtech., 13: 622-4(Dec. 1968). (In German).

Pickling and flushing of the austenitic parts of the Obrigheim reactor main coolant pipes are described, and the purity checkup and testing for ferritic contaminants are discussed. (H.D.R.)

15588 PRIMARY COOLANT PUMPS FOR THE KWO. Gaffal, K. (Schanzlin and Becker AG, Frankenthal, Ger.). Atomwirt., Atomtech., 13: 624-5(Dec. 1968). (In German).

The Obrigheim primary coolant pumps operating characteristics are presented, and the housing, shaft seals, cooling circuit gaskets, and thrust bearings are described. (H.D.R.)

15589 CHARACTERISTICS OF THE FABRICATION OF THE KWO PRESSURE VESSEL. Knoedler, D. (Siemens AG, Erlangen, Ger.); Ruf, R.; Weisser, E. Atomwirt., Atomtech., 13: 626-7(Dec. 1968). (In German).

Special features of the Obrigheim reactor pressure vessel are presented. The pressure vessel and cover fabrication and testing are described. (H.D.R.)

15590 PRIME SUPPLIERS FOR THE NUCLEAR POWER PLANT OBRIGHEIM. Atomwirt., Atomtech., 13: 628-30(Dec. 1968). (In German).

Firms which supplied engineering and construction services, components, electrical systems services, and testing services are listed. (H.D.R.)

15591 FABRICATION OF THE BOILERS FOR KWO. Borchardt, L. (Gutehoffnungschuette Sterkrade AG, Oberhausen, Ger.); Mayer, H. Atomwirt., Atomtech., 13: 630-1(Dec. 1968). (In German).

The tube plates, tubes, special fabrication procedures, and clean room conditions used in the manufacture of the Obrigheim reactor steam generators are discussed. (H.D.R.)

15592 INSTALLATION OF PROCESS COMPUTERS DURING STARTUP OF THE KWO. Marchl, A.; Pannewick, A. (Siemens AG, Erlangen, Ger.). Atomwirt., Atomtech., 13: 632-4 (Dec. 1968). (In German).

The process control computer of the Obrigheim reactor is described and its functions are examined. Program tests performed during the commissioning work are described. (H.D.R.)

15593 THE INITIATION OF THE AUTHORIZATION PROCESS FOR KWO. Kling, A. (Kernkraftwerk Obrigheim GmbH, Obrigheim, Ger.). Atomwirt., Atomtech., 13: 635-7(Dec. 1968). (In German).

Chronological steps in the Obrigheim licensing procedure are presented. (H.D.R.)

15594 TRAINING OF OPERATIONS PERSONNEL FOR THE KWO. Schweizer, E. (Kernkraftwerk Obrigheim GmbH, Obrigheim, Ger.). Atomwirt., Atomtech., 13: 637-8(Dec. 1968). (In German).

The special theoretical and practical instruction programs and the radiation protection training provided for the Obrigheim personnel are described. (H.D.R.)

15595 PLUTONIUM RECYCLING IN THE GARIGLIANO POWER PLANT. Colling, Armand. Euratom Rev., 7: 126-7(Dec. 1968).

The Pu recycling experiments at the Garigliano Power Reactor are described. (D.C.C.)

15596 CONCRETE REACTOR VESSELS ARE COMING TO U. S. Northup, T. E. Power, 113: 76-8(Feb. 1969).

The development of a prestressed concrete pressure vessel for the Fort St. Vrain Power Reactor is reviewed. Present construction of the pressure vessel is described. A list of world-wide reactors using prestressed concrete pressure vessels is included. (D.C.C.)

Power Reactor Development

Refer also to abstract 15561.

15597 (DOCKET-50231-25) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR. Facility Description and Safety Analysis Report, Amendment 26. (General Electric Co., Sunnyvale, Calif. Advanced Products Operation). Jan. 14, 1969. 5p. Dep. CFSTI.

The request for an extension of the construction completion date for the Southwest Experimental Fast Oxide Reactor (SEFOR) is included. (M.L.S.)

15598 (EUR-4193) PERFOR I: CALCULATION CODE OF PERFORMANCES OF AN ORGEL TYPE REACTOR. Chambaud, B.; Civardi, P.; Maurandy, C. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Aug. 14, 1968. 130p. (In French). Dep.

The computer program PERFOR I and FORTRAN 4 for the IBM 360 digital computer allows the determination of: the organic coolant temperature fine distribution, the cladding distribution temperature around a fuel rod, and the thermohydraulic performances at the channel level; and the total thermohydraulic performances at the reactor level. (auth)

15599 (EURFNR-541) STRUCTURAL, EXPANSION, AND DEFORMATION EFFECTS IN THE FAST REACTOR. PART II. PROGRAM DESCRIPTION. Hoang, Y. S. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorentwicklung). Translation of report KFK-539/II. 30p. Dep. CFSTI.

Work performed under United States-Euratom Fast Reactor Exchange Program.

Uses of the FORTRAN 2 computer programs DANGER, REAKSP, SPALTR, and TEMPER for the calculation of the deformation and expansion effects of the subassemblies in a fast reactor are described. (D.C.C.)

15600 (GA-8860) HTGR BASE PROGRAM. Quarterly Progress Report for the Period Ending August 31, 1968. (Gulf General Atomic, Inc., San Diego, Calif.). Sept. 27, 1968. Contract AT(04-3)-167. 38p. Dep. CFSTI.

ALUMINUM OXIDES — retention of uranium by fluidized beds of, analysis of pyrolytic carbon-coated uranium oxide (UO_2) fuel particle reprocessing
GRAPHITE — radiation effects on crystalline and dimensional changes in, measurement of fast neutron
NEUTRONS — effects on BISO-coated and Triplex particle-type uranium carbide (UC_2)
NEUTRONS, FAST — effects on crystalline and dimensional changes in graphite
REACTOR CONTROL ELEMENTS — reactivity worth of HTGR-type reactor, measurement of
REACTOR FUEL ELEMENTS — reactivity worth of HTGR-type reactor, effects of thorium concentration on
REACTOR FUELS — recycle schedule for HTGR-type reactor, analysis of optimum economic
REACTORS, GAS-COOLED — fuel recycle schedule for HTGR-type, analysis of optimum economic
THORIUM — effects of concentration on reactivity worth of HTGR-type reactor fuel elements
THORIUM CARBIDES — ThC_2-UC_2, fuel particle specifications for HTGR-type reactor, description of optimum
THORIUM OXIDES ThO_2-UO_2, fuel particle specifications for HTGR-type reactor, description of optimum
URANIUM CARBIDES — ThC_2-UC_2, fuel particle specifications for HTGR-type reactor, description of optimum
— radiation effects on BISO-coated and Triplex particle-type, analysis of neutron
URANIUM OXIDES $UO_2-ThO_2-UO_2$, fuel particle specifications for HTGR-type reactor, description of optimum
— fuel reprocessing of pyrolytic carbon-coated particles of effects of aluminum oxide (Al_2O_3) fluidized beds on uranium retention in (D.C.C.)

15601 (NP-17770) TENTH ACTIVITY REPORT. (European Nuclear Energy Agency, Paris (France)). Dec. 1968. 89p. Dep.

Topics discussed include: Joint Undertakings; Nuclear Power; Scientific and Technical Cooperation; Health and Safety; and Legal Affairs. (D.C.C.)

15602 (ORNL-TM-2136) GRAPHITE BEHAVIOR AND ITS EFFECTS ON MSBR PERFORMANCE. Kasten, P. R.; Bettis, E. S.; Cook, W. H.; (and others) (Oak Ridge National Lab., Tenn.). Feb. 1969. Contract W-7405-eng-26. 100p. Dep. CFSTI.

Graphite behavior under Molten-Salt Breeder Reactor (MSBR) conditions is reviewed and its influence on MSBR performance estimated. Based on the irradiation behavior of small-sized graphite specimens, a permissible reactor exposure for MSBR graphite is about 3×10^{22} neutrons/cm^2 ($E > 50$ keV). The stresses generated in the graphite due to differential growth and thermal gradients are relieved by radiation-induced creep, such that the maximum stress during reactor exposure is less than 1000 psi for reactor designs having a peak core power density of about 100 kw/liter and reactor exposures less than about $2\frac{1}{2}$ years. The corresponding power costs for single-fluid MSBR's would be about 3.1 mills/kwhr(e) based on a capital charge rate of 12% per year and an 80% load factor. Experimental data on graphite behavior also indicate that graphites with improved dimensional stability under irradiation can be developed, which would lead to improved reactor performance. The deposition of fission products on graphite does not appear to be large (10 to 35% of the "noble-metal" fission products based on MSRE experience); taking into account graphite replacement every two years, fission product deposition reduces the MSBR breeding ratio by about 0.002. It is concluded that good MSBR performance can be obtained by using graphite having combined properties presently demonstrated by small-size samples, and that development of MSBR graphite having such properties is feasible. (auth)

15603 (ORNL-tr-3010) POSSIBILITIES OF THE INDUSTRIAL CONSTRUCTION OF THE PRINCIPAL COMPONENTS OF A HIGH-TEMPERATURE POWER REACTOR. Brown, B. D.; Audinet, M. Translated for Oak Ridge National Lab., Tenn., from IAEA Symposium on Advanced and High Temperature Gas-Cooled

Reactors, Juelich, Germany, 21-25 October 1968. 25p. Dep. CFSTI.

A state-of-the-art discussion is presented on high-temperature power reactors. The components described include: internal structures; prestressed concrete container; heat-insulation; fuel handling machines; blowers; and steam generator exchangers. (D.C.C.)

15604 NUCLEAR REACTOR WITH A FAST NEUTRON COLUMN. Hachiya, Yuuki (to Nippon Electric Co., Ltd.). Japanese Patent 1968-24840. Oct. 26, 1968. Filed Apr. 27, 1966.

By the method proposed, fast neutrons can be obtained without using highly enriched U; in addition, the energy spectrum can be changed as required. An Al cylinder, which is lined with two layers of Cd and In, is placed vertically in the middle of the reactor core. Then, an Al cylinder of larger diameter is placed likewise in the core, surrounding the inner cylinder. The space produced between the two cylinders is packed with fuel rods (a moderator such as water may also be in the space). The inner cylinder serves the purpose of a fast neutron column. (NSA of Japan)

15605 NUCLEAR REACTOR. Morita, Takahiro (to Hitachi Ltd.). Japanese Patent 1968-23111. Oct. 4, 1968. Filed July 22, 1966.

In the nuclear reactor proposed, which has a two-region core with boiling water in the outer region, and steam superheating in the inner region, the abnormal increase in output at the boundary of the two regions can be removed. For the purpose, a liquid fuel region is located between the outer and the inner region; liquid fuel is circulated through an external device, to remove the produced Pu. (NSA of Japan)

15606 FUEL ELEMENT ASSEMBLY FOR A NUCLEAR REACTOR. Grant, Walter Lawrence (to Atomic Energy Board). U. S. Patent 3,420,738. Jan. 7, 1969. Priority date June 11, 1964, South Africa.

A fuel element assembly for a nuclear reactor is described which includes a tubular fuel container having inside it at least one inflow coolant duct and at least one outflow coolant duct. Nuclear fuel granules are located in the space defined between the tubular fuel container wall and the ducts. The ducts have multiple longitudinally spaced coolant outflow and inflow openings communicating with the space. (Offic. Gaz.)

15607 IMPROVEMENTS IN NUCLEAR REACTORS. Hawkins, Ronald James; Taylor, Peter Anthony; Dell, John David (to Babcock and Wilcox Ltd.). British Patent 1,141,294. Jan. 29, 1969. Filed Feb. 4, 1965.

A gas-cooled nuclear reactor is described comprising a concrete pressure vessel containing the core, and a heat exchanger located within a penetration in the wall of the vessel. The heat exchanger may be inserted into, and withdrawn from, the cavity as a unit from outside the pressure vessel. Means are provided through which the gas may flow, as the primary fluid, between the core and the heat exchanger, and inlet and outlet tubes pass from the penetration to the exterior of the vessel for a secondary fluid (in this case, water). (UK)

15608 GAS-COOLED FAST BREEDERS. Coburn, D. B. (Gulf General Atomic, Inc., San Diego, Calif.). Power Eng., 73: 30-2(Feb. 1969).

The development of U. S. gas-cooled fast breeder reactors is described. Typical performance data for a conceptual 1000 MW(e) helium-cooled fast breeder reactor are presented. (D.C.C.)

15609 THE TECHNICAL DEVELOPMENT OF SODIUM-COOLED FAST BREEDER REACTORS IN GERMANY. Guthmann, Elmar (INTERATOM GmbH, Bensberg, Ger.). pp 81-93 of Heutiger Stand und Tendenzen in der Entwicklung von Reaktoren. Schulten, R. (ed.). Essen, Vulkan-Verlag Dr. W. Classen, 1968. (In German).

From 2nd Reactor Meeting: Present State and Trends in Reactor Development, Essen, Germany. See CONF-671218.

Performance data and technical features of the 300 MW(e) Na-cooled fast breeder prototype under development are presented. The 5 MW(t) Na research facility is described, and some of the tests on Na pumps and components are discussed. (H.D.R.)

15610 PRELIMINARY ANALYSES OF THE GAS-COOLED FAST BREEDER REACTOR. Kawasaki Giho, No. 33, 80-6 (1968). (In Japanese).

Compared with the Na-cooled type, in the gas-cooled fast breeder reactor, there is no restriction in the design of reactor core to avoid the positive void coefficient of Na peculiar to the core of large power generating reactor, therefore the core size can be determined freely in accordance with the design objective, and the breeding ratio is high on account of the hard core spectrum. There are no countermeasure problems against strong chemical activity, induced radioactivity and thermal behavior of Na in the cooling system. Gas is inferior to liquid metal, in the heat removing ability. Therefore, the disadvantages of large pump power and high pressure cooling systems are unavoidable. The gas-cooled fast breeder reactor was analyzed and evaluated, and the studies on creep characteristics and sectional areas for neutron absorption of the fuel cladding materials, the possibility of heat removement from the core by cooling with CO_2 gas of 100 at. pressure, the equivalent heat removing conditions of CO_2 and He, and the nuclear characteristics of reactor with carbide fuel were carried out. The general performances of the gas-cooled fast breeder reactor were understood by this preliminary analysis. Hereafter, the detailed calculation and the investigation of the structure are intended to be carried out mainly about the reactor with oxide fuel. (NSA of Japan)

15611 POSSIBILITIES OF UTILIZING A HETEROGENEOUS COUNTER-CURRENT SYSTEM IN NUCLEAR REACTORS. Plavka, Ivan (Technical Univ., Bratislava). Jad. Energ., 15: 41-4(Feb. 1969). (In Czech).

The advantages of biphase counter-current flow through a stable spherical filling over parallel flow from the point of view of higher effectivity of the heat transfer process are discussed. The high intensity and effectiveness of the biphase process follows from some quantitative dependencies expressed in graphs. Two thermal cycle schemes for a nuclear power station are designed having in the principle a counter-current system. (auth)

15612 DEVELOPMENT OF NUCLEAR ENERGY USE WITH FAST NEUTRON REACTORS IN THE USSR. Leipunskii, A. I.; Afrikantov, I. I.; Kazachkovskii, O. D.; Orlov, V. V.; Pinkhasik, M. S.; Troyanov, M. F. At. Energ. (USSR), 25: 380-7(Nov. 1968). (In Russian).

A total of five fast-neutron, experimental reactors with liquid Na cooling and oxide fuel elements were built to investigate the suitability of ^{239}Pu fission for breeder reactors. The first, small, fast-neutron reactor showed a breeding coefficient of 2.5 ± 0.2. High fuel burnups have been obtained. Fast neutrons show smaller losses due to absorption, but special efforts are required to exclude light atoms from the core, since light elements slow down neutrons by collision very effectively. The high power density requires efficient heat removal. In large reactors it is expected that the breeding coefficient will fall to 1.3 to 1.5 compared to a value of 2.5 in small reactors. A large fast-neutron reactor of 600 megawatts (electrical) has been designed. With fast-neutron reactors it is possible to double the Pu fuel in 10 years, and thus, to save on the amount of U. A saving of 1.5 to 2.0×10^6 tons of U (a savings of 50 to 100 million dollars) is possible with fast neutron reactor use in electric power generation. (TTT)

15613 ANALYTICAL EVALUATION OF THE D_2O MODERATED POWER REACTORS. Mochizuki, Hiroji (Kawasaki Dockyard Co., Ltd., Japan). FAPIG (Tokyo), No. 50, 90-101(Aug. 1968). (In Japanese).

Analytical evaluation is presented on the D_2O-moderated power reactors: a CO_2-cooled reactor and a boiling light-water reactor. For the boiling water reactor, the feasibility of using natural uranium, and the nuclear heating characteristics to the Pu and natural uranium fuel were studied. It was shown that natural uranium could be used in the type of reactor, and that the positive void coefficient could be suitably suppressed. For the CO_2-gas cooled reactor, the heterogeneity effect in fuel arrangement in the channels, the dynamic characteristics and the nuclear safety were extensively studied, extending the range of CO_2 gas pressure. Also, the burn-up characteristic and the fuel-exchange characteristic, starting from natural uranium to the fuel of natural uranium and plutonium, were pursued. It was confirmed that the D_2O-moderated, CO_2-cooled reactor has superior properties as an advanced converter with few restrictions in design and operation. (NSA of Japan)

15614 APPARATUS FOR PRODUCING CONTROLLABLE SLOW NEUTRON CHAIN REACTION. Martin, A. F. (to Hercules Inc.). Canadian Patent 801,897. Dec. 17, 1968.

A reactor system is described in which all of the fissionable material in the critical mass exists as a powder suspended in, and moving with a gas which also serves to carry away a substantial portion of the fission energy. Along with the generation of nuclear energy there is a direct utilization of the fission fragment energy to cause chemical reaction in the gas in which the fissionable material is suspended. Such an arrangement is less expensive to build and operate than nuclear reactors using fixed fuel elements. The resulting energy is recovered in a suitable heat exchanger and converted to power. Economical utilization of γ rays and other reactor radiations to initiate desirable chemical reactions in the moderator is also exploited. A com-

paratively small core where the majority of the fission occurs allows the use of high pressure with attendant improvement in the heat exchange characteristics of the system. Only fast and slow neutrons contact the fuel, so intermediate neutrons will not be present in significant amounts to cause resonance capture. The system involves a reactor core containing a critical mass of fissionable material suspended as a powder in a coolant gas, a moderator surrounding the core, and several heat exchangers exterior to the core and moderator. Each heat exchanger and core has a suitable connection for the passage of the suspension of fissionable material and also a return means. There is continuous cycling from one to the other and also means for the addition of fissionable material and coolant gas to replace spent fuel and resulting fission products. (F.S.A.)

15615 WILL IT BE POSSIBLE TO DISPOSE OF THE RADIOACTIVE WASTE FROM A LARGE NUMBER OF NUCLEAR POWER STATIONS. Holtzem, H.; Schwibach, J. (Atomwirt., Atomtech., 13: 582-4(Dec. 1968). (In German).

Among the arguments which are still being advanced today in the German Federal Republic against the large scale introduction of nuclear energy for power generation is the objection that it will no longer be possible to dispose safely and economically of the radioactive waste if many large nuclear power stations are in operation. To examine this argument, it is first necessary to investigate where and in what form radioactive waste occurs. A distinction must be made between the residues from the used nuclear fuel elements and from the reprocessing plants and the waste which originates directly from the operation of reactors. On the basis of the currently accepted forecasts for the future development of nuclear energy it appears that the amount of waste accumulating in the Federal Republic up to the year 2000 will be less than the quantity which is already being stored in tanks in the USA. The USA has 20 years experience of this method of storage which shows that this problem is well under control. In addition, the basically safer processes involving the consolidation of the waste are already being evaluated. Their costs, inclusive of deep subterranean storage, will not be greater than those of tank storage which today are already included in the price of atomic power. Operating experience with American nuclear power stations shows in addition that, even today, radioactive materials need be removed from reactors on only a limited scale and that the costs of this make up only 3–5% of the overall operating costs. (auth)

15616 PILOT PROJECT DK 400. Mehlsen, S. (Danish Atomic Energy Commission, Risoe). Forsk. Udvikling-Uddannelse (Copenhagen), 77: 245-50(1968). (In Danish).

A 400 MW(e) power plant with a boiling heavy water reactor (BHWR) was investigated at the Research Establishment Risö in cooperation with some major power companies and industries in Denmark and with AB Atomenergi in Sweden. The plant uses the technology applied in the Swedish Marviken plant, apart from the superheating feature. The main features of the mechanical design are explained, and references are made to the reactor physics and heat transfer calculations performed in order to choose average channel power, U-235 enrichment, fuel shuffling scheme, and average fuel burn-up. The problems connected with the use of a direct heavy water steam cycle are explained. (auth) (Denmark)

15617 BOILING LIQUID REACTOR. Marchal, Raymond H. F.; Foure, Claude D. (to Societe Nationale d'Etude et de Construction de Moteurs d'Aviation). U. S. Patent 3,420,737. Jan. 7, 1969. Priority date Oct. 4, 1963, France.

For correct operation under low and/or variable gravity conditions a boiling water reactor comprises twisted strips between the fuel elements for directing the water-steam flow in a plurality of adjacent helical streams maintaining a water film against the fuel elements and a phase collection system located downstream of the core and out of the neutronic portion of the reactor. (Offic. Gaz.)

Kinetics and Dynamics

Refer also to abstract 15745.

15618 (AECL-3167) CALCULATION OF FAST NEUTRON FLUX IN REACTOR PRESSURE TUBES AND EXPERIMENTAL FACILITIES. Barnett, P. C. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). July 1968. 30p. Dep. CFSTI. CAN $1.00.

The computer program EPITHET was used to calculate the fast neutron flux (>1 MeV) in several reactor pressure tubes and experimental facilities in order to compare the fast neutron flux in the different cases and to provide a self-consistent set of flux values which may be used to relate creep strain to fast neutron flux. 15 references. (auth)

15619 (EUR-4092) DYNAMICS OF A 250 MW ORGEL POWER STATION USING FORCED FLOW HEAT EXCHANGERS (BENSON). Bona, C.; d'Hoop, H. (European Atomic Energy Community, Ispra (Italy). European Scientific Data Processing Center). Sept. 17, 1968. 66p. (In French). Dep.

The analog computer simulation of the 250 MW ORGEL prototype power station, which utilizes forced flow BENSON heat exchangers, is described. The mathematics model for the simulation and analog results are presented. (auth)

15620 LINEAR DYNAMICS MODEL FOR STEAM COOLED FAST POWER REACTORS. Vollmer, Heinz (Aktiebolaget Atomenergi, Studsvik, Sweden). Nucl. Sci. Eng., 35: 176-89 (Feb. 1969).

A linear analytical dynamic model is developed for steam cooled fast power reactors. All main components of such a plant are investigated on a general, though relatively simple, basis. The model is distributed in those parts concerning the core but lumped as to the external plant components. Coolant is considered as compressible and treated by the actual steam law. Combined use of analog and digital computer seems most attractive. (21 references) (auth)

15621 LOCALIZATION OF IN-CORE DISTURBANCES WITH EX-CORE DETECTORS. Baloh, Frank J.; Kenney, Edward S. (Pennsylvania State Univ., University Park). Nucl. Appl., 6: 232-7 (Mar. 1969).

A method for locating disturbances taking place inside an operating reactor by analyzing radiation emitted from the core uses two γ ray collimator-detectors to selectively monitor information from specific regions of the core. An analog computer was programmed to perform a cross-power spectral density analysis of the information and to eliminate information not common to both channels. A periodic disturbance worth approximately fifty millicents was used for the investigation. Disturbances located approximately 4 in. inside the core were detectable with the present system. With moderate improvement in equipment it is expected that perturbations could be located more than 1 ft inside cores of similar composition. (auth)

15622 THE EFFECT OF COOLANT pH ON REACTOR REACTIVITY. Sjoestrand, N. G. (Chalmers Univ. of Tech., Goteborg). Nucl. Sci. Eng., 35: 394-5 (Mar. 1969).

Some possible causes of observed reactivity variations in pressurized water reactors with an increase or decrease of coolant pH are discussed. (H.D.R.)

15623 OPTIMUM TRANSITION PROCESSES DURING POWER CHANGEOVER IN KS-1 TYPE REACTORS. Zaritskaya, T. S.; Il'ichev, B. I.; Rudik, A. P. Jad. Energ., 15: 45-9(Feb. 1969). (In Czech).

Transition time and reduced power were investigated during KS-type reactor shutdown. The relation between the transition period and stored reactivity was estimated. Optimum conditions were found requiring minimum interval between changeover in reactor from one stationary condition to another. (tr-auth)

Control Systems

15624 HYDROGEN REACTIVITY CONTROL EXPERIMENT. Rosenthal, H. B.; Szymkowiak, E. A.; George, C. H. (Martin–Marietta Corp., Baltimore). Nucl. Appl., 6: 191-8(Mar. 1969).

An experiment was performed to study the dynamic control of a reactor by H_2 transport and to demonstrate its load-following capabilities. The system is based on the mass transport of H_2 between two ZrH_X beds—one UO_2 fueled, the other unfueled. The in-core H_2 concentration controls the reactivity, and the resulting changes in reactor flux control the heat input into the in-core UO_2-fueled bed. In turn, the in-core H_2 concentration is controlled by changes in temperature differences between the in-core and out-of-core beds. The implementation and results of the experiment are discussed. Within analytical design constraints set by experimental and safety requirements, calculated ranges of parameters established design specifications. Preliminary validation measurements included reactor stability and temperature coefficient, experimental system stability and temperature coefficient, and in-core H_2 worth. Comparison showed that H_2 mass transport contributed 73% of the effectiveness of H_2 reactivity control while temperature contributed only 27%. All experimental transient responses to step changes in thermal load exhibited analytically predicted damped oscillatory behavior. Reactor startup, shutdown, and response to reactivity changes were demonstrated. The experiment verified that H_2 reactivity control, a mechanically passive device, is an effective, self-regulating mechanism for controlling a nuclear reactor. (auth)

Shielding

15625 (ANL-7117(Suppl.)) FINAL SURVEILLANCE OF EBWR PRESSURE VESSEL FOLLOWING THE PLUTONIUM RECYCLE PROGRAM. Balai, N.; Sutton, C. R.; Sims, M. R. (Argonne National Lab., Ill.). Sept. 1968. Contract W-31-109-eng-38. 20p. Dep. CFSTI.

Examination of the EBWR pressure vessel is discussed. The cladding was subjected to visual and dye-penetrant examinations. Destructive examinations were performed to determine whether the discovered cracks in the Type 304 stainless steel cladding propagated into the SA-212-B vessel wall. Results of fast neutron radiation damage on SA-212-B samples are described. (D.C.C.)

15626 SHIELDING DESIGN OF THE EXPERIMENTAL FAST REACTOR. Tanaka, Yoshihisa; Higashihara, Yoshiharu (Kawasaki Dockyard Co., Ltd., Japan). FAPIG (Tokyo), No. 50, 102-10(Aug. 1968). (In Japanese).

The shielding design of the experimental fast reactor, requested by JAERI in January 1968 as a part of the second conceptual design of the reactor, was completed in May the same year. Construction of the fast reactor with fuel irradiations as its main purpose will be started in 1970, with completion in 1972. In the work performed, an overall study was made on the shielding of the second conceptual design, and also problems involved were revealed. The description is made in the following: shielding of the reactor proper; shielding of the primary Na coolant system; shielding of the covering-gas system and the ventilating system; shielding of the reactor containment vessel; and technology of the fast reactor shielding. (NSA of Japan)

15627 NUCLEAR PRESSURE VESSELS: SITE ASSEMBLY. Dunn, J. T.; Christofferson, J. B. (Chicago Bridge and Iron Co., Oak Brook, Ill.). Mech. Eng., 91: No. 2, 32-3(Feb. 1969).

Techniques for the site assembly of steel pressure vessels for boiling water and pressurized-water power reactors are described. (D.C.C.)

15628 DESIGN AND CONSTRUCTION OF POWER REACTOR SHIELDS. Hungerford, H. E. (Purdue Univ., Lafayette, Ind.). Nucl. News, 12: No. 2, 41-6(Feb. 1969).

The complexities involved in designing a power reactor shield system are discussed, and the guiding design principles are summarized. Problem areas in design are examined, with particular emphasis on differences between fast and thermal reactor shields. The steps involved in preliminary design and analysis are reviewed, and shield construction and testing are discussed. (H.D.R.)

Cooling Systems

Refer also to abstracts 13853 and 13918.

15629 (BNWL-371(Pt.3)) CROSSFLOW MIXING BETWEEN PARALLEL FLOW CHANNELS DURING BOILING. PART III. EFFECT OF SPACERS ON MIXING BETWEEN TWO CHANNELS. Rowe, D. S.; Angle, C. W. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan. 1969. Contract AT(45-1)-1830. 80p. Dep. CFSTI.

Laboratory experiments were performed to determine the turbulent component of natural mixing that occurs between interconnected parallel channels typical of those in rod bundle nuclear fuel elements. An electrically heated model was used to simulate two subchannels formed by rods on a square pitch array. The model's size and range of operating conditions simulated a water cooled power reactor of current design. Average mixing was determined from the concentration of Li, deuterium and tritium tracers measured at the exit of the model's subchannels. The results of the experiments show that mixing during boiling is very different from mixing without boiling. Without boiling, mixing is nearly independent of rod spacing and nearly proportional to flow rate with a small dependence on Reynolds number. The same behavior occurs with "wart" type spacers in the gap between channels but with the mixing rate increased about 25%. During boiling, mixing is very dependent upon pressure, flow rate, gap spacing, and steam quality. Although mixing during boiling is significantly higher than mixing without boiling for most conditions, mixing during boiling can be less than single phase mixing for certain conditions. For both boiling and nonboiling conditions, a comparison with earlier data shows that the mixing rate between two channels formed by rods on a square array is about one-half the mixing rate between two channels formed by rods on a square array located next to rods on a triangular array. (auth)

15630 (ORNL-tr-3012) PURIFICATION OF HELIUM IN HIGH-TEMPERATURE REACTORS WITH A HELIUM EXPANSION CYCLE. Grison, Bruno; Simonet, Guy. Translated for Oak Ridge National Lab., Tenn., from IAEA Symposium on Advanced and Gas-Cooled High-Temperature Reactors, Juelich, Germany, 21-25 October 1968. 19p. (CONF-681008-7). Dep. CFSTI.

Purification systems for He-cooled high-temperature power reactors are described. A comparison of systems is made for reactors without a direct helium cycle and for reactors with a direct helium cycle and cooling by helium expansion. (D.C.C.)

15631 NUCLEAR REACTOR VESSEL. Chave, Paul; Rigal, Jean (to Commissariat a l'Energie Atomique). British Patent 1,142,890. Feb. 12, 1969. Priority date Sept. 3, 1965, France.

REACTOR FUEL ELEMENTS—assemblies of pressure-tube-type reactor, description of diaphragm-connected multiple longitudinally-arranged

REACTORS, PRESSURIZED-WATER—core of pressure-tube-type, description diaphragm-connected multiple longitudinal fuel elements in

15632 SODIUM AS A COOLANT FOR NUCLEAR PLANTS. Ash, E. B. Power, 113: 70-3(Feb. 1969).

The use of liquid Na as a fast breeder reactor coolant is discussed. Physical properties of liquid Na are compared with water. Advantages and disadvantages of using liquid Na are described. (D.C.C.)

15633 PRESSURE-EQUALIZED LIQUID-MODERATED GAS-COOLED NUCLEAR REACTOR. Gaudez, J. C.; Roche, R. (to Commissariat a l'Energie Atomique). Canadian Patent 798,550. Nov. 5, 1968. Priority date Aug. 28, 1964, France.

A proposed reactor design consists of a circuit for equalization of the coolant gas pressure and the moderator fluid pressure so as to balance the minimum gas pressure and the maximum fluid pressure, within their respective circuits. The calandria or moderator tank is suspended from the calandria tubes. This pressure equalization method avoids the danger of buckling the calandria tubes in a transverse sectional plane. Buckling as a result of axial compression is prevented by virtue of the suspension of the tank so that part of its weight is transferred to the calandria tubes which are thus subject to tensile stresses. The pressure equalization circuit comprises a vessel which is divided into two compartments by means of a movable partition and pipes for supplying coolant fluid to one compartment and moderator to the other. The partition consists of a layer of liquid lighter than the moderator and not miscible with it. This may be regarded as a fluid piston rather than the usual solid type in a cylinder. A prestressed concrete vessel provides coolant pressure containment and biological protection. (F.S.A.)

15634 SIMPLIFIED ANALYSIS OF COOLANT FLOW AND OUTLET TEMPERATURE IN GAS-COOLED NUCLEAR REACTOR CORES. Melese-d'Hospital, G. (Gulf General Atomic Inc., San Diego, Calif.). Nucl. Sci. Eng., 35: 165-75(Feb. 1969).

If the coolant mass flow were constant across the core, the coolant temperature rise would be proportional to the channel power. But, without orificing, the coolant mass flow in the hot channel is smaller than the average flow while the outlet temperature is hotter than the mixed mean temperature. The approximate radial distributions of coolant mass flow (M/M_0) and temperature rise ($\Delta T/\Delta T_0$) are shown to depend only upon the (arbitrary) radial flux distribution (H/H_0) and upon a single lumped core parameter (δ), proportional to the product of the pressure by the pressure drop. For simple radial flux distributions and when δ goes from zero to infinity, (M_0/M_{av}) increases approximately from (H_{av}/H_0) to one, while ($\Delta T_0/\Delta T_{av}$) decreases approximately from $(H_0/H_{av})^2$ to (H_0/H_{av}). The relationships between hot channel parameters, maximum clad or fuel temperatures, and thermal power are derived for a "chopped cosine" axial flux distribution. (auth)

15635 TWO-PHASE FLUID MODELING: THE CRITICAL HEAT FLUX. Staub, F. W. (General Electric Research and Development Center, Schenectady, N. Y.). Nucl. Sci. Eng., 35: 190-9(Feb. 1969).

Modeling of two-phase hydrodynamic phenomena with a refrigerant (Freon) has been carried out for several years because of the lower cost of experimentation with this working fluid. Freon-12 modeling of the critical-heat-flux condition, a coupled hydrodynamic thermal phenomenon, has recently been reported. An extension of the critical-heat-flux modeling work using Freon-22 is described. A recently proposed correlation method, comparing Freon and water data, has been modified, and good agreement is shown between water and Freon-22 test results in a round tube with and without a twisted ribbon insert. The modeling technique is also extended to cover inlet subcooling and the operating pressure effect. In addition, some liquid-metal and water critical-heat-flux data are compared. 27 references. (auth)

15636 BOILING OF ALKALI METALS. Grass, Guenther; Kottowski, Heinz (Joint Research Center, Ispra, Italy). Euratom Rev., 7: 107-13(Dec. 1968).

The various boiling mechanisms in forced convection systems are described. The physical properties of K, Na, and water are compared. A description of the technique of experimental investigation into boiling is presented. Superheating and separate-bubble ejection, film boiling, transpiration and perspiration cooling, and burnout are also discussed. (D.C.C.)

15637 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR PLANT. (to Babcock and Wilcox Co.). British Patent 1,141,927. Feb. 5, 1969. Priority date Apr. 20, 1965, United States.

HEAT TRANSFER SYSTEMS—turbines for superheating reactor, description of two-stage
REACTORS, SUPERHEATING—cooling system for dual-zone parallel-flow core, description of dual-stage turbine for
TURBINES—two-stage, for dual-zone parallel-flow superheating reactors

Fuels

Refer also to abstracts 14379, 14384, and 14415.

15638 (CEA-CONF-1093) TECHNICAL ASPECTS AND ECONOMIC INCIDENTS OF TRANSPORTATION IN THE FUEL CYCLE. Sousselier, Y.; Labrousse, M. (Commissariat a l'Energie Atomique [Paris] (France)). [1967]. 21p. (In (French). (CONF-680541-1). Dep.

From Symposium on Economics of Nuclear Fuels, Gottwaldov, Czechoslovakia.

The power reactor fuel cycle is discussed from the French point of view. Areas of U loss during processing and reprocessing are listed. Safety and economic aspects are discussed. Methods of fuel and spent fuel transportation used for the Chinon reactors and Bugey Power Reactor are described; the advantages of using Pb shielded casks are considered. Costs of transporting spent natural U fuel are detailed; cost breakdowns are given for France. Transportation costs for $UO_2(NO_3)_2$, Pu, and enriched U are considered briefly. Total fuel cycle costs for a gas-cooled graphite reactor are considered. (M.L.S.)

15639 (CONF-680832-2) TEMPERATURE DISTRIBUTION CAUSED BY GAS BUBBLES IN A SODIUM BONDED FUEL ROD. Preprint 16. Novendstern, E. H.; Bishop, A. A. (Westinghouse Electric Corp., Madison, Pa.). [1967]. 11p. American Institute of Chemical Engineers, New York, N. Y. $1.50.

From 10th National Heat Transfer Conference, Philadelphia, Pa.

An analysis of how large a stationary bubble must be before the local fuel surface and Na loud temperature reach the boiling temperature of pure Na is presented. Temperature distributions in the clad, bond and fuel are calculated for different size bubbles and bubble thickness. It is assumed the width of the Na bond is constant, that convection does not occur in the bond, and that the fuel is positioned concentrically in the clad. Effects of thermal radiation are evaluated. (auth)

15640 (GA-8895) GAS-COOLED FAST BREEDER REACTOR. Quarterly Progress Report, August 1-October 31, 1968. (Gulf General Atomic, Inc., San Diego, Calif.). Dec. 2, 1968. Contract AT(04-3)-167. 87p. Dep. CFSTI.

PLUTONIUM OXIDES PuO_2—PuO_2-UO_2, irradiation testing of gas-cooled fast breeder reactor fuel rods of
REACTOR FUEL ELEMENTS—radiation testing of plutonium oxide (PuO_2)-uranium oxide (UO_2), for gas-cooled fast breeder
REACTORS, GAS-COOLED—core development for fast breeder, Aug.-Oct. 1968
—fuel rod development and testing for fast breeder, Aug.-Oct. 1968 (H.D.R.)

15641 (GAMD-7284) PARTIAL-RECYCLE TECHNIQUES IN THE HTGR. Lee, D. H. Jr. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Nov. 7, 1966. Contract AT(04-3)-167. 9p. Dep. CFSTI.

An analysis of optimum fuel management for high-temperature gas-cooled reactors is presented. The effects of no recycle, full recycle, once-through partial recycle, and 0.8 recycle fraction on optimum management are compared. (D.C.C.)

15642 (GAMD-8813) IMPROVED FREVAP (-9) CODE FOR CALCULATING THE RELEASE OF METALLIC FISSION PRODUCTS FROM HTGR FUEL CORES. Zumwalt, L. R. (Gulf General Atomic, Inc., San Diego, Calif.). Aug. 1, 1968. Contract AT(04-3)-633. 6p. Dep. CFSTI.

The FREVAP-8 code for estimating the release of fission products from HTGR fuel elements and entire cores assumes that a steady-state is attained in the transport of fission products through the graphite of the fuel element. Experimental studies indicate there is a fast transport process at early times and that the transport of metallic fission products can be far from the steady-state condition at a given time and temperature. A mathematical formulation for FREVAP-9 which is designed to account for these effects is described. (H.D.R.)

15643 DOES A PEBBLE-BED BEHAVE LIKE A FLUID? Bedenig, Dietrich (Brown Boveri/Krupp Reaktorbau GmbH, [Duesseldorf], Ger.). Euratom Rev., 7: 118-23(Dec. 1968).

Data on the core structure and fuel circulation in the AVR reactor and the THTR prototype are presented. Direct and indirect measuring methods for pebble-bed mechanics are described. The pebble-bed flow pattern in the THTR core is analyzed. (D.C.C.)

15644 COMPARISON OF ENERGY SOURCES FOR THE ELECTRIC POWER INDUSTRY. O'Brien, R. P. Mining Congr. J., 54: 88-95(Feb. 1968).

Costs of generating electricity by coal, nuclear power, natural gas, water power, and oil in the U.S.A. are compared. Future requirements of energy in the U.S.A. are forecast till 2000 and fuel reserves in the U.S.A. and worldwide are given. Air pollution must be solved if coal is to maintain its share of the market. The choice of energy source will depend particularly on its ability to maintain a stable price over a long period. (UKAEA Infor. Bull.)

15645 UTILIZATION OF NUCLEAR RAW MATERIALS FOR POWER PRODUCTION IN YUGOSLAVIA. Suica, Salom (Federal Commission of Nuclear Power, Belgrade). Jad. Energ., 15: 37-40(Feb. 1969). (In Czech).

The problems of nuclear raw material utilization in power production and material requirements in the application of different types of nuclear reactors in long-term development of nuclear power in Yugoslavia are analyzed. The nuclear portion of the total electricity production in the country is supposed to be increased to 9% in 1980 and to 42% at the end of the century. The calculation results of the total U consumption have been compared for 6 variants. The optimum variant is based on the combination of heavy water converter and fast reactor breeder. The comparison of the total nuclear fuel consumption in the case of all solution variants with the existing and estimated U reserves in Yugoslavia leads to the possibility of covering needs from own sources. The estimated U reserves in Yugoslavia may cover the fuel requirements of the nuclear power production from 1975 to 2025. (auth)

Auxiliary and Emergency Systems

15646 PRESSURE EQUALIZING DEVICES SUITABLE FOR USE IN POWER-WATER REACTORS. van den Honert, Alexander (to North American Philips Co., Inc.). U. S. Patent 3,417,815. Dec. 24, 1968. Priority date Oct. 7, 1965, Netherlands.

A pressure equalizing device for equalizing pressure fluctuations in a closed fluid circulating system is described. The device consists of a container having a lower portion connected by a first conduit to a portion of the system operating at a given pressure and providing the lower portion with a reservoir filling of the liquid. The upper portion is connected by a conduit to a second portion of the system operating at a lower pressure. A liquid heater is provided in the container and is positioned within the reservoir filling. The second conduit comprises a heat exchanger disposed within the lower container portion in the reservoir filling. (Offic. Gaz.)

Operation and Economics

15647 NUMBER OF PROBLEMS OF OPERATING ATOMIC POWER PLANTS IN ENERGY SYSTEMS. Dollezhal', N. A.; Koryakin, Yu. I. At. Energ. (USSR), 25: 387-94(Nov. 1968). (In Russian).

Because of variable demand, even nuclear power plants will not be able to operate at high use factors, particularly after 1980 when nuclear reactors will represent a larger part of the energy economy. Hence it is desirable to consider the flexibility of various kinds of reactors. The drop in cost of electrical energy with a decrease in the use factor is particularly large in the case of fast neutron breeder reactors because of high fixed costs and low

fuel cost. The fast neutron reactors also breed fuel for an expanding nuclear economy. Hence, it is desirable to have thermal neutron reactors as regulating reactors, since they operate at high burnups of 20,000 to 30,000 megawatt-days/ton, and they do not have a high fuel inventory. A desirable feature of a power complex would be the use of reversible hydroturbines which can operate either as generators or as pumps. The possibility of lower use factors will have an effect on the reactor equipment such as loading and unloading machines, on fuel recovery and fuel cycling, and on the relative importance of conversion efficiency (high efficiencies will be more desirable). It is necessary and desirable to include thermal reactors with moderate use coefficients in any overall energy system. (TTT)

15648 ATOMIC POWER PLANTS. Feinberg, S. M. At. Energ. (USSR), 25: 363-80 (Nov. 1968). (In Russian).

Since nuclear power plants are more economical than ordinary thermal power plants even in areas with relatively cheap sources of organic fuels, it is of interest to review the work done on various types of nuclear power plants from the point of view of economics. The technical aspects of gas-cooled, light-water and heavy-water, pressurized and boiling reactors are reviewed briefly. The capital cost, the fuel cost, the annual requirements of natural U, and the annual production of fissionable Pu are listed for these reactors. The capital costs and fuel costs are estimated in 1980 with an assumed doubling in the price of U. The availability of U at various prices is estimated at 1.3×10^6 tons at 10 to 20 dollars/kg, 1.2×10^6 additional tons at 20 to 30 dollars/kg, and 1.5×10^6 additional tons at 30 to 60 dollars/kg. The number of reactors, and total reactor power are summarized for various countries. The total energy requirements, plant power capacity, percent nuclear power of the total power, doubling time, and U requirements are estimated for the years 1965, 1970, 1975, 1980, 1990, and 2000. Methods of introducing breeder reactors into the national, electrical power economy are suggested. U requirements are estimated for various combinations of reactor types. (TTT)

15649 NUCLEAR ENERGY PRODUCTION AND ITS ROLE IN TECHNICAL PROGRESS. Aleksandrov, A. P. At. Energ. (USSR), 25: 356-62 (Nov. 1968). (In Russian).

Although nuclear energy supplies less than 1% of present energy requirements, this 1% is of great importance because of the promise of unlimited energy in the near future. Because of its high energy intensity, nuclear fuel can be transported at low cost. Hence, cheap nuclear energy resources will be available to fuel-short countries. At present, power plants relying on the fission of ^{235}U of thermal neutrons are competitive with power plants operating on conventional fuels. Pu can be bred in fast neutron reactors by supplying only ^{238}U from the outside. At present less than 1% of the ^{238}U in thermal neutron reactors is utilized. With electrical power growth doubling in 7 to 10 years, a Pu doubling time of 3 to 4 years would be required in breeder reactors in order to assure proper growth. Thermal neutron breeder reactors which would convert Th to ^{233}U can also serve as competitors to the fast neutron breeder reactors. It appears likely that the cost of nuclear energy can be lowered to the point where it will be possible to recover water by distillation of seawater in areas where water is at a premium. The electrical energy from a dual-purpose nuclear plant can be used in such energy-intensive processes as metal recovery by electrolysis, production of NH_3 for fertilizer, and other chemical processes. The potential decreases in cost of electrical energy from nuclear fission would be of great economic significance. (TTT)

15650 COAL SUBSIDIES AND SUPPORT FOR NUCLEAR ENERGY: ARE THEY IN CONFLICT. Seetzen, J. (Kernforschungszentrum, Karlsruhe, Ger.). Atomwirt., Atomtech., 13: 586-7 (Dec. 1968). (In German).

Today in the German Federal Republic the government simultaneously spends money subsidizing the output of coal and supporting the advancement of nuclear reactor development. This energy policy frequently appears contradictory and comes in for criticism. Fundamentally, however, these measures are only indirectly concerned with each other. The coal subsidies are based only on the price of fuel oil and not on the lower price of nuclear energy. On the other hand the support for reactor development applies in the first instance to future reactor generations and not to the nuclear power stations which are already competitive today. Neither energy source would directly benefit from ending the subsidies or the support. Nevertheless, the situation is unsatisfactory. An examination of its origin shows that the energy policy was in no way determined by false forecasts even though the forecasts, particularly that of 1957, have not been fulfilled in detail. The situation is rather due to the setting of wrong economic targets. For the European national economies the aim of a self-sufficient energy economy is not compatible with the aim of a high standard of living. (auth)

15651 THE IMPORTANCE OF FAST BREEDER REACTORS IN A NUCLEAR ECONOMY. Jansen, P. J. (Kernforschungszentrum, Karlsruhe, Ger.). pp 70-80 of Heutiger Stand und Tendenzen in der Entwicklung von Reaktoren. Schulten, R. (ed.). Essen, Vulkan-Verlag Dr. W. Classen, 1968. (In German).

From 2nd Reactor Meeting: Present State and Trends in Reactor Development, Essen, Germany. See CONF-671218.

Fast breeder power reactor economics in relation to other reactor types is analyzed for various load factors. Power production requirements from thermal converter–fast breeder and fast converter–fast breeder development strategies are projected to the year 2020, and fuel requirements and cost data are presented for the various reactor types. (H.D.R.)

Safety and Siting

Refer also to abstracts 13864 and 13869.

15652 (BNWL-943) FISSION PRODUCT TRANSPORT BY NATURAL PROCESSES IN CONTAINMENT VESSELS. Knudsen, J. G.; Hilliard, R. K. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan. 1969. Contract AT(45-1)-1830. 98p. Dep. CFSTI.

A calculational procedure is developed and described for predicting the time-dependent concentration of molecular vapor forms of fission products contained in a closed vessel with a condensing steam-air atmosphere. The model predicts iodine behavior substantially as found by large-scale experiments in the 30,000 ft^3 Containment Systems Experiment containment vessel. In seven large-scale experiments, elemental iodine transfer rate from the gas phase to surfaces averaged 8% lower than predicted by the model for the gas diffusion limiting period. (auth)

15653 (CONF-680832-6) EXPERIMENTAL RESULTS OF REACTOR SYSTEM BLOWDOWN AND CORE HEAT TRANSFER TESTS. House, R. K.; Finnegan, L. J.; Jensen, R. T.; Curet, H. D. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Aug. 13, 1968. 36p. Dep. CFSTI.

From 10th National Heat Transfer Conference, Philadelphia, Pa.

Experimental studies were conducted using small scale, simplified model equipment to investigate coolant depressurization and heat transfer processes occurring during a loss-of-coolant accident in a nuclear reactor system. Analytical predictions of coolant blowdown, agree reasonably well with experimental data. One area of nonagreement is the transition regime between subcooled and saturated blowdown. This regime is not accurately predicted by current analytical models for the simple vessel geometry used in the experiments. Steady-state temperature distributions in a simulated reactor core were obtained experimentally. Fluid did not flow through the core and radiation and conduction were the predominate heat transfer mechanisms. The comparison of the steady-state temperature distributions obtained experimentally with analytical results from the MOXY code is not good, and the code is being revised. The preliminary results of core spray and flooding heat transfer tests allowed the detailed heat transfer mechanisms associated with spray and flooding cooling to be identified. The experimental results also provided basic information on the effectiveness of spray and flooding ECC injection in terminating a cladding temperature transient in small simulated fuel pin arrays. (auth)

15654 (DOCKET-50231-26) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR. Facility Description and Safety Analysis Report, Amendment 27, Suppl. 22. (General Electric Co., Sunnyvale, Calif. Advanced Products Operation). Jan. 24, 1969. 12p. Dep. CFSTI.

Consequences of leaks in the primary systems of the Southwest Experimental Fast Oxide Reactor (SEFOR) are analysed. Detection of leaks in the primary system is discussed. Equipment needed to recover from a guillotine pipe failure is evaluated. Schematics of argon gas piping at the refueling cell and siphon breaker hole locations are included. (M.L.S.)

15655 (EURFNR-579) THEORETICAL STUDY OF HYPOTHETICAL SERIOUS ACCIDENTS IN FAST POWER REACTORS. Braess, D.; Thurnay, K. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Translation of report KFK-813. 18p. Dep. CFSTI.

Work performed under United States–Euratom Fast Reactor Exchange Program.

In the design of fast power reactors the safety considerations are governed by the investigation of second excursions. These ex-

cursions might occur when there is an assumed failure of the cooling system and, at the same time, a breakdown of all safety devices. Second excursions are mostly studied with the Bethe-Tait-Method. This method is developed further and the effect of Doppler feedback and of delayed neutrons is studied. (auth)

15656 (HN-194) EFFECT OF HUMAN ERROR AND STATIC COMPONENT FAILURE ON ENGINEERED SAFETY SYSTEM RELIABILITY. Garrick, B. J.; Gekler, W. C.; Goldfisher, L.; Shimizu, B.; Wilson, J. H. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Nov. 1967. Contract AT(10-1)-205; Subcontracts C-275; C-623. 93p. Dep. CFSTI.

For Holmes and Narver, Inc., Los Angeles, Calif.

Human error and static component failure are important variables in system reliability especially if these failures can lead to system failure by themselves or in connection with only one other failure. The results indicate that no generalization can be made as to when a static component or human failure must be included unless it is that they should be ignored or separately treated. General practice has been to consider human-initiated equipment failures as being included in equipment failure rate data, or to adjust equipment failure rates to be compatible with known environmental factors or controllable human factors which reflect expected maintenance practices. In cases where the operator is an integral part of system operation, it has been assumed that the operator is completely reliable. Appropriate failure distributions for static components are available and can be used in the ARMM and SAFTE programs. Reliability data to support the failure distribution is limited. (auth)

15657 (ORNL-4337) A NUCLEAR SAFETY PARTICLE PRIMER. Davis, R. J. (Oak Ridge National Lab., Tenn.). Jan. 1969. Contract W-7405-eng-26. 78p. Dep. CFSTI.

A survey of aerosol science is presented which has the objective of providing a short list of phenomena which could account (to one significant figure) for the aerosol concentration in a water-cooled reactor containment as a function of time after a very severe accident. Three categories of aerosol science are discussed: formation of particles; mechanics of particles; and surface chemistry of particles. Particles are expected to form primarily by condensation of vapor from an overheated core. There appears to be sufficient theory available to estimate the effects of core surface temperature and sweeping gas temperature and velocity on the primary particle size. The primary particle size is the minimum particle size which exists later. The minimum particle size largely determines the settling rate; hence, nucleation conditions could influence the concentration of aerosol in the containment as a function of time after an accident. Useful calculation schemes are available for estimating filtration efficiencies of fibrous filters. Some calculations are reported to demonstrate effects of several environmental parameters. Condensation of water on the filter is probably the most serious potential problem. Particle removal by natural effects in the containment will occur as a result of many phenomena. The most important are probably: coagulation and settling, and diffusiophoresis and thermophoresis (which sweep particles toward surfaces onto which water is condensing). Estimation, from first principles, of particle concentration in the containment vs time as a result of coagulation and settling is extremely complicated. A method for an approximate calculation is presented and demonstrated. The equations are also developed for particle concentration vs time as a result of diffusiophoresis and thermophoresis. Removal by all mechanisms is also estimated. The important surface chemistry of particles includes the reaction with iodine and with water. Water can affect the shape of agglomerate particles, and thereby increase the penetration through a filter. Water can condense in quantity on particles, make them larger and make them settle faster. Estimates of the effect of this phenomena on concentration in the containment vs time are presented; the effect can probably be very important. 34 references. (auth)

15658 (TID-24936) CONSIDERATIONS AFFECTING STEAM POWER PLANT SITE SELECTIONS. (Office of Science and Technology, Washington, D. C.). Dec. 1968. 145p. Dep. GPO $1.25.

The present state of knowledge, and the lack of knowledge, of the public interest considerations that should play a role in planning the power plants of the future is presented. The dimensions of the siting problem are delineated by examination of projected electric power generating requirements, and the physical requirements for siting large power plants are identified. Atomic Energy Commission criteria for approval of nuclear power plant sites and research efforts for future nuclear plant standards are reviewed. Air and water pollution problems are described, and control programs of the Department of Health, Education, and Welfare, the Department of the Interior, and State agencies are outlined. The impact of large power plants on fish and wildlife and aesthetic and recreational values of adjacent lands is discussed, and their impact on rural economies is examined. The relationships of reliability of electric power service and of economy and flexibility of transmission to plant siting are presented. Special aspects of siting are examined for multipurpose plants, such as power-desalination plants and plants which would be the hub of an agro-industrial complex. The activities of the various State agencies in power plant siting are summarized, and novel programs undertaken by four different States are discussed. (H.D.R.)

15659 (WAPD-T-2155) VOID FRACTION AND RESIDUAL WATER PREDICTIONS DURING LOSS OF COOLANT. Redfield, J. A.; Murphy, J. H. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Sept. 1968. Contract AT-11-1-GEN-14. 11p. (CONF-681101-12). Dep. CFSTI.

From International Conference on the Constructive Uses of Atomic Energy, Washington, D. C.

A modification to the FLASH program bubble rise velocity model is presented which produces an increased capability to describe void fraction experiments and residual water measurements after blowdown tests. The modified model shows an improved capability to describe LOFT semiscale blowdown tests over the full range. (H.D.R.)

15660 REACTOR SAFETY STUDIES BASED ON AGR MODELS. Nakano, Makoto; Ogushi, Kozo (Fuji Electric Co., Japan). Fuji Jiho, 41: 676-82(Sept. 1968). (In Japanese).

As a part of the study on the safety of advanced gas-cooled reactors, experiments were carried out with a model imitating the decrease in heat removal capacity. The purpose was to affirm the validity of a mathematical model, to observe such points as difficult with the mathematical model, and to obtain data basic for the safety of advanced gas-cooled reactors. By comparing with the results of experiment, it was found that the theoretical results on their average behavior were on the conservative side, with accuracies sufficient for such safety analyses. Using the method of analysis, the accidents in advanced gas-cooled reactors could be minimized by taking suitable measures. (NSA of Japan)

15661 NUCLEAR SAFETY. Volume 10, No. 2. Cottrell, Wm. B.; Jordan, W. H.; Blakely, J. P.; Savolainen, A. W. (eds.). One of Four Technical Progress Reviews Published for the Division of Technical Information, USAEC. Oak Ridge, Tenn., Oak Ridge National Lab., Mar.-Apr. 1969. 78p. GPO $0.60.

Seven sections on material related to nuclear safety are included. Separate abstracts are prepared for each of the seven sections. (M.L.S.)

For abstracts of individual sections see: 14255, 15568–15570, and 15662–15664.

15662 RADIATION IN PERSPECTIVE: THE ROLE OF NUCLEAR ENERGY IN THE CONTROL OF AIR POLLUTION. Fish, B. R. Nucl. Safety, 10: 119-30(Mar.-Apr. 1969)

Nuclear energy can play a critically important role in combating the growing assault on the purity of our atmosphere by supplanting fossil-fuel energy for most of the power plants to be built late in the century. Even then the same tight control that is currently exercised over the nuclear industry must come into being for other industries that are actual and/or potential polluters of the atmosphere. Several air-pollution disasters of the past emphasize the potential for future disasters. (35 references) (auth)

15663 COMPILATION OF COMPUTER CODES FOR NUCLEAR ACCIDENT ANALYSIS. Winton, M. L. Nucl. Safety, 10: 131-47(Mar.-Apr. 1969).

Many computer programs have been developed for use in various aspects of nuclear accident analysis. The Nuclear Safety Information Center has separated 131 of these codes into 12 categories and tabulated them. The resulting table gives name of code, machine it was designed for, its language, the corporate author, a statement of what the code does, and a reference citation. In addition, there is notation of those codes on which information may be obtained from the Argonne Code Center. (132 references) (auth)

15664 PROGRESS SUMMARY OF NUCLEAR SAFETY RESEARCH AND DEVELOPMENT PROJECTS. Savolainen, A. W.; Whetsel, H. B. (comp. and ed.). Nucl. Safety, 10: 179-87(Mar.-Apr. 1969).

A summary of nuclear safety research and development is given on: Fast Reactor Safety including fast reactor meltdown studies, coolant dynamics, material behavior and energy transfer, defected and vented fuel behavior, safety experimentation for fast reactor development, accident analysis and safety evaluations, and fission product release studies; Gas Cooled Reactor Safety including fission product behavior and steam–graphite reactions, large scale steam graphite test, and behavior of gasborne fission products at high temperature; Effluent Control–Environmental Studies;

Effluent Control–Waste Treatment and Disposal Program; and General Safety Studies including NSIC, Computer Handling of Reactor Data-Safety (CHORD-S), and heavy section steel technology program. (31 references) (M.L.S.)

15665 STUDIES ON THE LOSS-OF-COOLANT ACCIDENT IN WATER-COOLED NUCLEAR POWER REACTORS. II. Takekoshi, Tadasu; Nakata, Seibei; Nishiwaki, Ichiro; Shimizu, Sadaaki; Inami, Kuniaki; Kasuga, Yasuhiro. Denki Shikensho Iho, 32: 975-99(1968). (In Japanese).

A blowdown test section simulating a double ended pipe rupture has been set up in the PWR loop to develop information on the blowdown phenomena associated with a loss-of-coolant accident in water-cooled power reactors. Provisions simulating a double ended break are located close to the coolant inlet of the reactor vessel, and instrumentations are included to measure the transient behavior of the coolant on the pressure and mean density in the reactor vessel, on the pressure drop between the vessel and the break point, and on the critical pressure at the break point. Parametric blowdown tests have been performed to evaluate the effect of the rupture size and rupture mode on the rate of change of void fraction and coolant pressure during the blowdown. Blowdown code based on a phase-separation model has been developed successfully to analyze the features of double ended break. The major conclusions are as follows. The experimental and analytical results show that there exists a marked influence of phase separation on the blowdown phenomena in the case of double ended break, and that the rate of change of void fraction takes a similar order of magnitude as compared with a single ended blowdown from the break point close to the coolant inlet of the reactor vessel. The flow resistance of the primary circuit during the blowdown is closely coupled with the rupture area of the break point, and computed results of the critical pressure based on a homogeneous model shows good agreement with experimental ones. (auth)

15666 EFFECTS OF CONDENSATION ON THE TRANSPORT OF MATTER FROM VAPOR AND NONCONDENSABLE GAS MIXTURES. Oezisik, M. Necati; Hughes, Daniel (North Carolina State Univ., Raleigh). Nucl. Sci. Eng., 35: 384-93(Mar. 1969).

The steady-state flux of matter of molecular size from a mixture of vapor and noncondensable gas to the walls of a large containment vessel during the condensation of vapor can be predicted with the analysis. A boundary layer approach has been used in formulating the mass-transfer problem and the resulting equations are solved numerically. Charts are presented for the flux of molecular iodine from a steam–air mixture to the walls of the containment vessel during the condensation of steam. Knowing the total pressure and the temperature of the bulk mixture, the wall temperature, and the concentration of air and iodine in the bulk mixture, the rate of removal of iodine from the vessel can be predicted. The analysis is correlated with an experiment and close agreement is found. 8 references. (auth)

15667 ANALYSIS OF THE TRANSIENT BOILING OF LIQUID METALS. Judd, A. M. (Atomic Energy Establishment, Winfrith, Eng.). J. Phys., D (London), 2: 261-74(Feb. 1969).

In the course of fast reactor safety studies various problems associated with the transient boiling of liquid metals have arisen. Some of these of general interest, associated with nucleation, bubble growth and channel voiding, are discussed. The differences between the behavior of liquid metals and water are emphasized, and in particular the effects of dissolved gas and ionizing radiation are dealt with. An approximate method of calculating the rate of growth of a vapor bubble is described, which includes the effects of inertia, heat transfer and surface tension. This is applied to the voiding by boiling of a blocked reactor coolant channel. (auth)

15668 RADIOACTIVITY BUILDUP IN REACTOR COMPONENTS. Bartlett, John W. (Battelle Memorial Inst., Columbus, Ohio). Power Eng., 73: 36-7(Feb. 1969).

An analysis of corrosion product buildup radiation levels in boiling and pressurized-water reactors is presented. Safety procedures for emergency situations are described. Radionuclides of concern include ^{60}Co, ^{58}Co, ^{51}Cr, ^{59}Fe, and ^{54}Mn. (D.C.C.)

Power Conversion Systems

15669 (CEA-CONF-1042) EXPERIMENTS ON "SIRENE" IN-PILE THERMIONIC CONVERSION AND EXAMINATION AFTER IRRADIATION OF THE "SIRENE 302" CONVERTER. Bliaux, J.; Clemot, M.; Devin, B.; Dumas, P. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). [1967]. 14p. (In French). (CONF-680508-7). Dep.

From 2nd International Conference on Thermionic Electrical Power Generation, Stresa, Italy.

Lifetime experiments made in the Triton swimming pool reactor are reported. The three converters described are similar and were irradiated in individual capsules. The emitting surface is 20 cm^2 and has a pyrolytic covering of W. The interelectrode space is 0.2 mm. The Cs pressure is controlled by the temperature of a graphite block (which is close to that of the collector) or by the temperature of a classic Cs reservoir. Lifetimes of the order of 2000 hrs were obtained. The measurements made during these tests are presented. The results of the post-irradiation examination of the Sirene-302, made in a hot cell, are also presented: perturbation of the emitting surface, UO_2–Mo reaction, evaporation transfer of UO_2, behavior of the graphite, and verification of the short circuit emitter-collector. These results confirm those obtained previously in laboratory experiments. (tr-auth)

15670 (ORNL-tr-3011) PROBLEMS AND OPTIONS CONCERNING HELIUM TURBINES. Chaboseau, Jean; Maillet, Ennemond. Translated for Oak Ridge National Lab., Tenn., from IAEA Symposium on Advanced and Gas-Cooled High-Temperature Reactors, Juelich, 21–25 October 1968. 15p. (CONF-681008-6). Dep. CFSTI.

The problems of using the direct-cycle turbine design for high-temperature helium-cooled power reactors are analyzed. (D.C.C.)

Research and Test Reactors

Refer also to abstracts 14011, 14169, 14293, 14377, 15568, and 15738.

15671 (ANL-7458) DEVELOPMENT OF BRAZING TECHNIQUES AND PROCEDURES FOR FABRICATING FUEL SUBASSEMBLIES FOR THE ARGONNE ADVANCED RESEARCH REACTOR (AARR). Kolba, V. M.; Pearson, C. V.; Kramer, W. C. (Argonne National Lab., Ill.). Aug. 1968. Contract W-31-109-eng-38. 109p. Dep. CFSTI.

The design of the AARR included rhomboidal fuel subassemblies of Type 347 stainless steel-clad fuel plates. A standard subassembly contained 27 plates of highly enriched spheroidal UO_2 uniformly dispersed in a Type 347 stainless steel matrix. The fuel plates were to be spaced and supported by square wires welded or brazed vertically at intervals along the edges and continuously along the axial centerline. Rhomboidal Type 347 stainless steel end fittings were to be welded to plate extensions at the top and bottom. Brazing was selected as the method of fuel plate assembly, and the program implemented to develop optimized brazing process-product specifications for use in vendor-qualification tests and ultimate AARR fuel subassembly commercial fabrication is described. Brazing development activities and test fabrication of full-scale dummy fuel-plate assemblies are presented, and the reference fabrication procedure is outlined. (H.D.R.)

15672 (ANS-RPD-1, Paper 5) STUDIES OF UNRESOLVED RESONANCES WITH A 2 keV BEAM. Simpson, O. D.; Miller, L. G. (Idaho Nuclear Corp., Idaho Falls). 20p. (CONF-680601-56).

Neutron cross section variation measurements as a function of energy in the unresolved region are described. Measurements, made in the MTR, utilised a scandium neutron filter with a fast chopper. Beam intensity and neutron flux greater than 2 keV are given for the HB-3 beam hole. Background, gamma beam intensity, and attainable beam diameters are described. Results of measurement of change in cross section as a function of sample temperature are discussed; comparisons of 2 keV fission cross section data are tabulated. Mock calculations of ^{181}Ta and ^{239}Pu cross section dependence on energy are discussed; data are shown graphically. Average resonance parameters for ^{239}Pu from Saclay, ENDF-B, and LASL are tabulated. 25 references. (M.L.S.)

15673 (BNWL-541) FAST FLUX TEST FACILITY QUARTERLY TECHNICAL REPORT, APRIL–JUNE 1967. Astley, E. R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan. 1969. Contract AT(45-1)-1830. 153p. Dep. CFSTI.

Efforts were directed toward the achievement of a more comprehensive conceptual design of the Split Core Concept. Seven conceptual variations of the reactor were devised. Conceptual designs were developed for structures and containment, heat removal, fuel handling, irradiation testing, and fuel examination. Studies and development supporting the conceptual design were made in core and systems analysis, in safeguards, physics, fuels, corrosion, chemistry, and metallurgy. (auth)

15674 (BNWL-CC-1012) AN EVALUATION OF THE REQUIREMENT FOR INSTRUMENTING ALL FUEL CHANNELS IN

THE FFTF. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). [nd]. 10p. Dep. CFSTI.

The considerations of the various purposes for instrumenting test and driver fuel elements in the FFTF are presented. The minimum requirements for this instrumentation are described. (D.C.C.)

15675 (BNWL-SA-1688) ANALYSIS OF COOLANT MIXING IN THE FFTF FUEL BUNDLE. Padilla, Andrew Jr. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar. 14, 1968. Contract AT(45-1)-1830. 32p. (CONF-680832-3). Dep. CFSTI.

From 10th National Heat Transfer Conference, Philadelphia, Pa.

Coolant mixing studies in the fuel bundle which were carried out during the conceptual stage in the design of the FTR are presented. The purpose of these studies was to: (1) determine the temperature and flow distribution in the fuel bundle, (2) provide a technical basis for instrumentation of the driver subassembly, and (3) identify thermal-hydraulic problem areas in the design of the driver subassembly. (auth)

15676 (IDO-17289) SPERT PROJECT. Quarterly Technical Report, April-June 1968. Taxelius, T. G. (ed.) (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Jan. 1969. Contract AT(10-1)-205. 22p. Dep. CFSTI.

REACTOR FUEL ELEMENTS—failure testing of Zircaloy-2 clad pelletized uranium oxide (UO_2), in SPERT IV Capsule Driver Core

REACTOR SAFETY EXPERIMENTS—power excursion in SPERT 3 E-core, description of unplanned

—fuel rod failure testing in SPERT 4 Capsule Driver Core, summary of Zircaloy-2 clad pelletized uranium oxide (UO_2)

URANIUM OXIDES, UO_2—fuel elements of Zircaloy-2 clad, failure testing in SPERT 4 Capsule Driver Core of

ZIRCALOY-2—cladding for pelletized uranium oxide (UO_2) fuel elements, failure testing in SPERT 4 Capsule Driver Core of (H.D.R.)

15677 (NP-17764) UTILISATION OF A RESEARCH REACTOR. Ten Years of Apsara. (Bhabha Atomic Research Centre, Bombay (India)). [1965]. 82p. Dep.

Topics discussed include: Reactor; Reactor Instrumentation; Neutron Physics; Nuclear Fission; Nuclear Spectroscopy of Short-Lived Nuclei; Irradiation Studies of Chemical Compounds; Agricultural and Biological Applications; Isotope Production; Activation Analysis; and Health Physics. (D.C.C.)

15678 (ORNL-4342) FABRICATION PROCEDURES FOR THE INITIAL HIGH FLUX ISOTOPE REACTOR FUEL ELEMENTS. Adamson, G. M. Jr. (comp.) (Oak Ridge National Lab., Tenn.). Feb. 1969. Contract W-7405-eng-26. 147p. Dep. CFSTI.

Procedures by which ORNL fabricated the first High Flux Isotope Reactor fuel assembly are described. Quality of starting materials, pressing of complex $U_3O_8-Al-B_4C$ dispersion cores, rolling and forming of fuel plates, assembly and welding of fuel elements, inspections performed throughout the procedure, and quality of intermediate and final products are reported. An entire HFIR fuel loading comprises two elements, inner and outer annuli containing 171 and 369 fuel plates, respectively. The high neutron flux and heat production rate require nonlinear fuel loading variation across the plates, accurate shaping of plates, and fabrication to close tolerances. The cladding and structural alloy was 6061 Al. (auth)

15679 (UNC-5193) FAST REACTOR MIXED-CARBIDE FUEL ELEMENT DEVELOPMENT PROGRAM. First Quarterly Progress Report, July-September 1967. (United Nuclear Corp., Elmsford, N. Y. Research and Engineering Center). Nov. 15, 1967. Contract AT(30-1)-3415. 38p. Dep. CFSTI.

EXPERIMENTAL BREEDER REACTOR-II—fuel rods for, fabrication and testing of plutonium carbide (PuC)-uranium carbide (UC)

PLUTONIUM CARBIDES—PuC-UC, fabrication and testing of EBR-2 fuel rods of

RADIATION TARGET CANS—design of instrumented, for sodium-bonded EBR-2 fuel rod testing

REACTOR FUEL ELEMENTS—development of mixed carbide, for fast breeders

—fabrication of plutonium carbide (PuC)-uranium carbide (UC) rods for EBR-2

REACTORS, BREEDER—fuel elements for, development of mixed carbide

REACTORS, FAST—fuel elements for, development of mixed carbide

URANIUM CARBIDES—PuC-UC, fabrication and testing of EBR-2 fuel rods of (H.D.R.)

15680 ACCIDENT ANALYSIS FOR A FAST SOURCE REACTOR. Mathis, A. (CNEN-CSN, Rome); Musso, B.; Turrini, E. Energ. Nucl. (Milan), 15: 444-54(July 1968). (RT/ING-(68)19.

The methods used for the accident analysis of the TAPIRO fast source reactor are described. The accidents considered are various kinds of reactivity insertions, leading possibly to meltdown of the core. The study is based mainly on the use of analog computer models. (auth)

15681 THE INFLUENCE OF THE RADIATION LOOP ACTIVITY GENERATOR ELEMENTS ON THE ACTIVE SECTION OF AN IRT IN WATER REFLECTOR. Dindun, A. S.; Gavar, V. V.; Mikelson, A. E.; Tomson, E. Ya. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser., No. 5, 14-18(1968). (In Russian).

Experimental measurements of the influence are considered at different generator variants and structural materials located in the water reflector. A generator supplied with an In-Ga-Sn alloy was found to exercise the maximum influence of 1.5% ($\Delta k/k$) against one core edge and to decrease exponentially to zero at a 120 mm distance from the edge. (auth)

15682 EXPERIMENTAL STUDIES ON 20 PERCENT ENRICHED URANIUM-LIGHT WATER ASSEMBLY (TITAN). I. Takeda, E.; Miyawaki, Y. (Tokyo Inst. of Tech.). Tokyo Kogyo Daigaku Gakuho, No. 83, 1-5(Mar. 1968).

The TITAN, of Tokyo Institute of Technology, is a flexible subcritical assembly, using 20% enriched uranium as the fuel and light water as the moderator. The initial fuel loading experiment, carried out to measure the critical mass, is described. In order to overcome the difficulty in estimation of the critical mass by the highly subcritical experiment, the following method was used: spontaneous fission neutrons instead of an extraneous neutron source; symmetric fuel loading to the detector; and improvement of the multiplication plot. By this procedure, it was found that about 80% of the critical mass was sufficient to give the critical mass estimate with 10% error. (NSA of Japan)

15683 MEASUREMENTS ON THE DIFFUSION LENGTH AND THE AGE OF NEUTRONS IN WATER, DIPHYL, AND HB-40. Benedetti, F. (SNAM PROGETTI, Milan); Boffi, V.; Brighenti, G.; Casali, F.; Garagnani, A.; Giuliani, C. Energ. Nucl. (Milan), 16: No. 2, 22-9(Feb. 1969).

The results of static measurements on the diffusion length and the age of neutrons in some organic compounds are reported and discussed. They are at last compared with the experimental data available in the literature. 14 references. (auth)

15684 CRITICAL ASSEMBLY AT THE INSTITUTE OF PHYSICS AT THE ACADEMY OF SCIENCES OF THE LATVIAN SSR. Tomson, E. Ya.; Gavar, V. V.; Dindun, A. S.; Janson, Yu. M. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser., No. 5, 82-8(1968). (In Russian).

The critical assembly was put into service in September 1966 in Salaspils. The core of an IRT reactor is used in the assembly. Maximum operating thermal capacity is 10 W. The assembly is intended for modulating the radiation loop and experimental conditions of the IRT-2000 reactor of the Institute. (auth)

15685 In-Ga-Sn ALLOY ACTIVATION IN THE ACTIVITY GENERATOR ELEMENTS OF RADIATION LOOP IN THE WATER REFLECTOR OF AN IRT REACTOR. Dindun, A. S.; Gavar, V. V.; Mikelson, A. E.; Tomson, E. Ya. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser., No. 5, 9-13(1968). (In Russian).

Experimental investigation of the specific and the summary activity of In-Ga-Sn alloy (24, 62, 14 wt.% correspondingly) in the tubular elements of the generator located in the water reflector of the IRT reactor core is discussed. The In-Ga-Sn alloy activation by thermal and epicadmium neutrons is also studied. (auth)

15686 THE NUCLEAR REACTOR UNDER CONSTRUCTION AT THE TECHNICAL UNIVERSITY, BUDAPEST. Csom, Gyula (Technical Univ., Budapest). Fiz. Szemle, 18: 376-8(Dec. 1968). (In Hungarian).

Construction of the KFKI reactor, to be used for research and teaching, was started late in 1966 on the basis of preliminary plans prepared at the Central Research Institute for Physics of the Hungarian Academy of Sciences after consultation with Soviet experts; all of the detailed plans have been developed in Hungary. Construction is scheduled to be completed by March 1970. The automatic control equipment, the electrical system and structural portions of the core are being fabricated in Hungary; the fuel elements and some specialized instruments will be supplied by the Soviet Union. As the reactor will be used to train inexperienced students, operational safety received great emphasis. The EK-10

type fuel elements, containing 10% enriched UO_2 rods in 1.5-mm thick aluminum cladding have been found reliable. Light water serves as moderator and coolant. The core contains 20 fuel bundles, surrounded by a 14-cm thick graphite reflector and a 20–24 cm thick light-water reflector. Five horizontal beamholes and a large experimental area will be made available for research; vertical channels will be used for the manufacture of short-lived radioisotopes and for irradiation experiments. Facilities for radiation chemistry and radiation biology are also provided for in the design. (TTT)

15687 MEASUREMENT OF THE PARTIAL DROPPING TIME OF SAFETY RODS. Bekkering, J. A.; Braun, H. W. M. (EURATOM, Ispra, Italy). Kerntechnik, 10: 681-3(Dec. 1968). (In English and German).

Use of the piston, located at the end of the ESSOR safety rod, for rod drop time measurements is described. The designs of the safety rod and test rig are described; rod drop time measurements are discussed briefly. (M.L.S.)

15688 CRITICAL MEASUREMENTS ON AN ENRICHED URANIUM SOLUTION SYSTEM. Rothe, Robert E. (Dow Chemical Co., Golden, Colo.). Nucl. Sci. Eng., 35: 267-76(Feb. 1969).

Critical parameters are reported for an essentially unreflected system containing U solution and a fixed neutron poison. The U solution contained 450.8 g of U per liter. The U was enriched to 93.19 wt % ^{235}U. The fixed poison was natural B contained in stainless steel plates and comprised 1.02 wt % of the plates. The total B content was varied on successive runs by changing the number of plates. The plates were arranged along parallel chords of the 106.6-cm-diam cylindrical experimental tank; they were approximately uniformly spaced. Three types of measurements are reported. The first type provides data on an unpoisoned slab. In the second type, the U solution height at criticality was less than the height of the plates (119 cm) and provided data on a poisoned solution cylinder. When the B concentration was 16.41 g/liter, the cylinder was subcritical even if infinitely long. The third type of measurement, where the critical U solution height exceeded the plate height, allowed an evaluation of the interaction between an unpoisoned slab and a highly poisoned region. The highest B concentration measured was 20.62 g/liter. The experimental data are compared with results from neutron transport and diffusion computer codes. Computer results also provide asymptotic values for critical parameters not amenable to measurement because of apparatus limitations. The computer was used to extend the applicability of the data to more general systems. 16 references. (auth)

15689 MATERIAL BUCKLING MEASUREMENTS WITH 2.1 WT PERCENT ^{235}U ENRICHED URANIUM TUBES IN LIGHT WATER. Brown, C. L. (Battelle Memorial Inst., Richland, Wash.); Hansen, L. E.; Toffer, H. Nucl. Sci. Eng., 35: 358-63 (Mar. 1969).

Exponential and critical approach experiments were performed to determine material bucklings and extrapolation distances for several hexagonal lattice arrays of 2.1 wt % ^{235}U tubes in light water. Tubes of two sizes were measured—2.33-in. o.d., 1.77-in. i.d.; and 1.38-in. o.d., 0.63-in. i.d. The arrays included clean lattices of U tubes; U tubes containing $LiAl_5O_8$ target rods; U tubes with adjacent neutron absorbing columns; and two mixed lattices of 0.95 and 2.1 wt % enriched tubes—one with the 0.95 and 2.1 wt % tubes evenly distributed in the lattice, and the other with the 0.95 and 2.1 wt % tubes arranged in alternate rings. These experiments supplement data obtained in 1965 for 1.002, 1.25, and 1.95 wt % enriched U tubes. Critical parameters for these lattices, calculated with the HAMMER code, agree reasonably well with the measured results. (auth)

15690 DESCRIPTION AND ANALYSIS OF THE CRITICAL ACCIDENT AT THE VENUS REACTOR AT MOL, DECEMBER 30, 1965. Penelle, G. (CEN, Mol, Belg.). pp 1223-30 of Radiation Protection. Part 2. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968. (In French).

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.2)).

On December 30, 1965, a technician attached to the Venus Reactor of the CEN at Mol was highly irradiated during a manipulation of reactor control rods. The Venus Reactor (Vulcan Experimental NUclear Study) constitutes the nuclear model of the Vulcain reactor; it is for the determination of the principal physical characteristics of the Vulcain. A brief description of the installations of the Venus Reactor, necessary to a good comprehension of the circumstances of the accident, is presented. The accident was caused when the technician wished to extract a control rod from the reactor core; he applied in an erroneous fashion an order of operation which, itself, did not conform with orders controlling the reactor operation. The chain of circumstances and the sequence of maneuvers which led to the accident are reported. The analysis of this sequence was made from the viewpoint of the reactivity balance. The reactor shutdown resulted from the drop of the rod manipulated by the technician; exceeding the predetermined radiation levels caused, also, the automatic draining of the reactor vessel. The sequence of events which followed the nuclear surge is described. After the accident an examination of the condition of the reactor was made; the conclusions are given. Numerous studies were also made on the doses received by the exposed technician and on the physical aspects of the accident. The dosimetry studies were treated previously. The results of the studies on the kinetics, the energy released during the surge, and the nature of the radiations released are reported. The principal conclusions drawn from the study of the accident are summarized. (tr-auth)

Rocket and Space Reactors

Refer also to abstract 14660.

15691 (LA-DC-10338) KINETICS EQUATION FOR A CLUSTER OF ROVER REACTORS. Hansen, Gordon E. (Los Alamos Scientific Lab., N. Mex.). Mar. 1965. 10p. Dep. CFSTI.

A kinetics equation capable of giving the time-dependence of fission rates in individual cores of a clustered array of Rover reactors is developed. All parameters introduced are defined in terms of computable functions of the basic nuclear properties of the system. (H.D.R.)

15692 (N-68-31043) THE DOUBLE CONTAINMENT TANTALUM–STAINLESS STEEL SNAP-8 BOILER. Gertsma, L. W.; Thollot, P. A.; Medwid, D. W.; Sellers, A. J. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). 1968. 15p. (NASA-TM-X-52452; CONF-680802-9). CFSTI.

From 3rd Annual Intersociety Energy Conversion Engineering Conference, Boulder, Colo.

A major problem in the development of the SNAP-8 space power system has been the Hg boiler, principally due to the incompatibility of containment materials with Hg. As an approach to the solution to this basic problem, a boiler utilizing Ta for the Hg-containment material was designed for the SNAP-8 system and tested for 1445 hours. Because of safety requirements, the design incorporated double containment of the Hg, which in effect separated the radioactive primary loop fluid from Hg by two metal walls and buffer region filled with NaK. Design features which allowed the use of a Ta tube within a stainless steel (SS) tube are discussed. These include both an oval SS containment tube and a bellows to allow for differential thermal expansion and the need for bimetallic joints. Thermal design of the boiler is described. The overall operating history and a comparison of test results with predicted performance indicate the boiler fulfilled its design requirements. (auth) (STAR)

15693 (N-68-35073) COMPARISON OF SMALL WATER–GRAPHITE NUCLEAR ROCKET STAGES WITH CHEMICAL UPPER STAGES FOR UNMANNED MISSIONS. Clark, M. Ray; Sagerman, Gary D.; Lahti, Gerald P. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). (NASA-TN-D-4827).

Payload performance and the radiation environment characteristics of this small reactor type (200 to 600 MW power) in a nuclear upper stage are considered. Payload dose criteria indicate that any shielding requirement would be based on propellant heating considerations. Several approaches to propellant heating, including subcooled or slush H_2 propellant and shielding, are compared. Potential performance gains are outlined for the Saturn 1B and 260-inch solid launch vehicles when employing orbital nuclear start engine firing, optimum nuclear thrust, and subcooled H_2 propellant. Payload sensitivity to the nuclear-stage jettison weight and to the shielding approach to propellant heating is illustrated. (auth) (STAR)

15694 (RN-S-92) REVIEW OF NERVA HEAT TRANSFER ANALYSIS. NERVA PROGRAM. (Aerojet-General Corp., Azusa, Calif.). June 1964. Contract SNP-1. 76p. Dep. CFSTI.

A review of presently available information regarding heat transfer correlations and pressure drop predictions for H_2 in the various phases as encountered in normal nuclear rocket operation is presented. Recommendations are made concerning specific equations to be used for selected ranges of temperature and pressure. In the case of forced convective boiling heat transfer much additional study both experimental and analytical must be accomplished before suitable equations are available for use

in design. Abnormal heat transfer and fluid flow phenomena which could result in problems within a reactor during phases of operation are also discussed. A discussion of the digital computer codes presently available at WANL for analysis of the reactor during various phases of operation is presented. 52 references. (auth)

15695 (WANL-W-89) NERVA DEVELOPMENT STATUS. Esselman, W. H. (Westinghouse Electric Corp., [Pittsburgh,] Pa. Astronuclear Lab.). Feb. 23, 1968. Subcontract NP-1. 20p. (CONF-680214-1). Dep. CFSTI.

From American Nuclear and Professional Engineers Society Conference, Cocoa Beach, Fla.

The basic operation of a nuclear reactor rocket system is reviewed, and the status of the NERVA development program is assessed. Technical objectives of structural integrity and reactor endurance capability, engine restartibility, and predictibility and controllability of the system are discussed, and future development potential is examined. (H.D.R.)

15696 EFFECT OF MODERATION ON DAMAGE FLUX IN FAST REACTORS. Cohen, S. C.; Mathews, D. R. (Gulf General Atomic, Inc., San Diego, Calif.). Nucl. Appl., 6: 199-201(Mar. 1969).

The effect of moderator incorporation in a fast reactor on the magnitude of the integrated neutron flux above 1 MeV (damage flux) is examined. Numerical results utilizing a diffusion theory model are presented for fuel-moderator mixtures and thermionic converter-moderator mixtures. The effect on the damage flux of core power density reduction is shown to be far more significant than that of moderator removal. (auth)

Process Heat and Desalination Reactors

15697 (EUR-4090) TECHNICAL AND ECONOMIC STUDY ON THE DESALINATION OF SEAWATER AND BRACKISH WATER. Vaudo, A.; Baldetti, S. (Montecatini Edison, Milan (Italy)); Pelecier, C.; Micheli, M. (Societa Italiana Weir ed Itam, Milan). Nov. 1968. Contract 030-66-5 ECII. 151p. (In Italian). Dep.

The economic value in France and Italy of the use of desalinization processes as compared with traditional supply systems is assessed. Present and future water requirements (up to 1975) are examined, and it is concluded that these data do not give grounds for forecasting a general water shortage. However, there are areas of present shortage which make it seem reasonable and advantageous to develop medium-capacity desalinization plants (50,000–100,000 m^3/d). An analysis of the various processes and a survey of the plants operating on an industrial scale confirm that the multiflash system is the most economic and technically advanced. On this basis a parametric calculation is made of the cost of water in single and dual-purpose plants for plant capacities ranging from 50,000 to 250,000 m^3/d, using a conventional thermal source or a nuclear source (ROVI, CANDU and ORGEL reactors). The results reveal an undoubted advantage in the use of nuclear energy, and in particular for plants of more modest capacity of the ROVI reactor. The costs obtained for single-purpose plants in conjunction with their operational flexibility, show them to be economically well-suited to the forecast market requirements and comparable with dual-purpose plants. (auth)

15698 (ORNL-tr-2078) CONTRIBUTION TO THE ECONOMIC STUDY OF MULTIPURPOSE PLANTS: POWER PRODUCTION, DESALINATION OF SEA WATER AND CHEMICAL INDUSTRIES. Douvry, R.; Dorges, P. E. Translated for Oak Ridge National Lab., Tenn., from IAEA Symposium in Nuclear Desalination, Madrid, November 1968. 20p. (CONF-681108-2). Dep. CFSTI.

Problems associated with the optimum operation of multipurpose nuclear reactors are described. The combination of power production, desalination, and chemical production in reactor systems is discussed. Aluminum, chlorine, and phosphorus production systems are analyzed. (D.C.C.)

15699 THE COMBINATION OF LARGE ATOMIC ELECTRIC POWER PLANTS WITH DESALINATION DISTILLATION UNITS. Churin, A. I.; Klyachko, V. A.; Koryakin, Yu. I.; Solov'ev, G. M.; Loginov, A. A.; Rybachev, V. V. At. Energ. (USSR), 25: 394-402(Nov. 1968). (In Russian).

The most economical reactor would be one which produced electrical energy, heat, and distilled water, since the reactor power could be used to satisfy peak demands at various times of the year and day. Fast reactors, and thermal reactors of channel construction (water-graphite), seem to be the most promising in supplying the large sums of heat required. Schematic arrangements for producing supercritical steam with these reactors are presented. Research on water desalination is being carried on in the city of Shevchenko where a ten-unit, vertical-tube distillation unit with an output of 18,000 m^3/day has been installed. An economic analysis shows that it is possible to produce distilled water in a triple-purpose nuclear power plant at a cost of 3 to 5 kopecks/m^3. The cost varies as a function of plant size. Costs are given for a water-graphite reactor with superheated vapor and without vapor superheat, and for a fast reactor. At Shevchenko, a large industrial center, a nuclear energy desalination unit with a distilled water capacity of 120,000 m^3/day is under construction. (TTT)

15700 HIGH-TEMPERATURE REACTORS AND THE STEEL INDUSTRY. Siebker, Manfred; Martin, Henri. Euratom Rev., 7: 124-5(Dec. 1968).

The use of high-temperature gas-cooled reactors to provide energy for steel production is analyzed. Two direct reduction processes with nuclear reactors as power sources are described. (D.C.C.)

Marine and Portable Power Reactors

Refer also to abstract 15568.

15701 ON THE MOTIONS AND ACCELERATIONS OF THE JAPANESE FIRST NUCLEAR SHIP IN WAVES. Yamanouchi, Yasufumi; Takaishi, Yoshifumi. Senpaku Gijutsu Kenkyujo Hokoku, 5: 91-145(July 1968). (In Japanese).

Model experiments to predict the ship motions and accelerations induced on the Japanese First Nuclear Ship in waves were carried out. The responses of the model ship in regular and irregular waves generated in the model basin were measured. The test results in regular waves are shown as the amplitude ratio to wave height or wave slope against the ship length-wave length ratio for the various wave directions and ship speed. The responses in irregular waves whose energy spectrum was given as a certain standard type are shown as the standard deviations of the responses to the significant wave height against the velocity for the various wave directions and the mean wave period. The test results were compared with the computed values by the so-called strip theory. The short term distribution of the responses in irregular extreme sea condition was estimated and compared with the values derived from the foregoing researches. Thrust increase in regular and irregular waves was also measured and the speed loss in rough seas was considered. (NSA of Japan)

15702 RESEARCH WORK ON NUCLEAR SHIPS. Senpaku Gijutsu Kenkyujo Hokoku, 5: 147-67(July 1968). (In Japanese).

The outline of research and development of nuclear ships, which have been carried out at the Ship Research Institute from April 1964 to March 1968, is described. Some considerations on radioisotope utilization are added. (NSA of Japan)

15703 NUCLEAR CONTAINER SHIPS: ARE THE COSTS RIGHT. Lawes, G. New Sci., 41: 336-8(Feb. 13, 1969).

The role of a container ship driven by a nuclear reactor is discussed, together with new UK proposals for such a vessel. The type of reactor considered is a burnable poison PWR. (UK)

15704 MAIDEN VOYAGE OF "OTTO HAHN" UNDER NUCLEAR POWER. Boos, Hans. Euratom Rev., 7: 128(Dec. 1968).

The startup and testing programs of the "Otto Hahn" nuclear powered ship are described. Results from the October 11 and October 12, 1968, trial voyages are also described. (D.C.C.)

15705 ON THE FIRST NUCLEAR SHIP IN JAPAN. Fune No Kagaku, 21: No. 10, 52-68(Oct. 1968). (In Japanese).

The details of hull, machinery and nuclear reactor plant of the ship are shown. UO_2 fuel charged in the reactor is about 2.6 tons with the replacement of fuel every 2 years. The fuel cost is more than 6 yen per hp hour, and more than 5 times as much as the conventional ship. The facilities in the usual mooring port, the construction schedules of the ship and the port, the training program of crews, and the construction cost and the expenses are also described. (NSA of Japan)

Production Reactors

15706 (DP-MS-67-98) COST-PRODUCTION MODEL OF A USAEC NUCLIDE PRODUCTION FACILITY: USE IN COST EFFECTIVENESS STUDIES. Topp, S. V. (du Pont de Nemours (E. I.) and Co., Aiken, S. C. Atomic Energy Div.). Apr. 16, 1968. 12p. (CONF-680545-1). Dep. CFSTI.

From Joint Meeting of Operations Research Society of America and the Institute of Management Sciences, San Francisco.

A computer model was developed to calculate operating modes, costs, and requirements for scarce materials as a consequence of widely varying radioactive nuclide demands on the nuclear reactors at the Savannah River site. Operating modes to meet certain product requirements while maximizing the production of other desirable products are calculated, as are fixed and variable costs and capital requirements. The model is used in cost effectiveness studies of net return or special product unit cost based on product unit values under conditions or uncertain product values. The interaction of this model with others to form an optimization technique for the complete USAEC nuclide production complex and a simplified version of the model for locating broad regions of near-optimum operation are discussed. A description is given of the evolution of the model into a tool useful in forecasting actual budgets and plant operating schedules. (auth)

15707 (DPSPU-68-30-4) OPERATING EXPERIENCE WITH AIRBORNE ACTIVITY CONFINEMENT SYSTEMS AT THE SAVANNAH RIVER PLANT. Hinton, J. H.; Temple, C. J. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Plant). July 1968. 10p. (CONF-680811-12). Dep. CFSTI.

From Symposium on Operating and Developmental Experience in the Treatment of Airborne Radioactive Wastes, New York.

The activity confinement system for production reactors at the Savannah River Plant (SRP) is designed to collect airborne radioactive particles and halogen vapors that might be released to the atmosphere in a reactor accident that damages the reactor fuel. Other protection systems are provided to prevent activity release to the atmosphere by terminating the accident prior to fuel damage and by providing multiple, reliable cooling systems to remove nuclear decay heat. The confinement system consists of moisture separators, filters, and halogen adsorbers to remove airborne activity (primarily solid particles and ^{131}I vapor) from the reactor area exhaust air. Noble gas activity is not removed by this system. The air passes through the filters and carbon beds before being discharged to a 200-foot stack. Since the system is always on-line, no manual or instrument action is required to assure confinement at the time of an accident. The operating experiences during five years of continuous operation are presented. (auth)

Reactor Theory

Refer also to abstracts 14856, 15691, and 15696.

15708 (BNWL-940) DIGITAL SOLUTION OF THE REACTOR KINETIC EQUATIONS BY THE THETA METHOD FOR FAST (FFTF) AND THERMAL REACTORS. Burnett, R. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Feb. 1969. Contract AT(45-1)-1830. 46p. Dep. CFSTI.

Three variations of a digital integration formula known as the Theta method were used to solve the nuclear reactor point kinetics equations on a Digital Equipment Corporation PDP-7 computer. The equations were also solved by trapezoidal integration. A three-delay-group model was programmed with thermal reactor parameters. Printout solutions were obtained for a reactivity step input of −0.005 and were compared to an analytical solution. For other reactivity inputs, hybrid equipment was used to compare the digital results to an analog solution computed simultaneously on a Beckman EASE 2133 analog computer. The analytical and analog solutions were assumed to be the "true" solutions. Fast reactor constants were then inserted and the tests repeated. A simple modification of one of the weighting parameters displayed a definite accuracy advantage over integration by the trapezoidal rule in the calculation of fast transients, although it required nearly two and one-half times the solution time of the trapezoidal method. In the case of more slowly changing power levels, the trapezoidal rule was able to nearly match the accuracy of the Theta method. A simplified variation of the Theta method required only 20 to 35% more solution time than trapezoidal integration while handling fast transients nearly as well as the more complex Theta variation. With the fast reactor model, the Theta and trapezoidal methods produced nearly identical results; both had good accuracy. (auth)

15709 (LA-4024) HETEROGENEITY EFFECTS IN A RADIALLY LOADED REACTOR. LaBauve, R. J. (Los Alamos Scientific Lab., N. Mex.). May 1968. Contract W-7405-eng-36. 9p. Dep. CFSTI.

Calculations for one-, two-, and simulated three-dimensional cell models of a radially loaded reactor are compared. The final results from the more detailed cell calculations differ only slightly from the results of the simpler calculations. (auth)

15710 (SC-DC-69-1630A) THERMOMECHANICAL ANALYSIS OF FAST BURST REACTORS. Reuscher, J. A. (Sandia Labs., Albuquerque, N. Mex.). [1968]. 5p. (CONF-690102-3). Dep. CFSTI.

From Fast Burst Reactor National Topical Meeting, Albuquerque, N. Mex.

The various methods for calculating the thermomechanical effects of rapid heating on the core of a fast burst reactor are reviewed, and some comparisons between theory and experiment are provided. The narrow power pulse causes the temperature of the core to rise faster than the fuel material can respond by thermal expansion. A small portion of the thermal energy becomes kinetic energy causing the core to vibrate and inducing large dynamic stresses in the fuel material. In addition to the determination of stresses for evaluation of fuel integrity, it is important to calculate displacements since the movement of the core surfaces determines the burst characteristics of the reactor. 6 references. (auth)

15711 STABILITY OF THE FLAT THERMAL FLUX IN A SLAB REACTOR. Bartosek, Vaclav; Zezula, Rostislav (Inst. of Nuclear Research, Rez, Czech. Charles Univ., Prague). Apl. Mat., 13: 367-75(1968). (In Czech).

Using the qualitative theory of differential equations the authors demonstrate the equivalency of the boundary value and of the initial Cauchy's value for the problem of the flat flux in the slab reactor. The existence of an interval of the initial (central) fuel concentrations is proved; for this interval Cauchy's problem (with two algebraic conditions) describes a critical flat flux reactor. Solutions which apply for the outside of this interval describe subcritical systems or a non-multiplying medium. (JPRS)

15712 A SIMPLIFIED, INTEGRAL METHOD FOR NEUTRON THERMALIZATION IN A URANIUM-D_2O LATTICE WITH PLUTONIUM. PART 2. Bonalumi, R.; Palazzi, F.; Pierini, G. (CISE, Milan). Energ. Nucl. (Milan), 16: No. 2, 10-21(Feb. 1969).

The calculation of epithermal cross sections is carried out for a U-D_2O lattice, where the fuel may contain Pu isotopes and cooling is provided by a high temperature hydrogeneous coolant. The epithermal cross-sections include the relevant disadvantage and shielding factors, which are dependent on the amount of moderation. Westcott-like effective cross sections are also derived. Some comparison with experiments and with THERMOS calculations is also reported, showing the accuracy of the model: each problem takes about 2 sec on the IBM 7040 digital computer. (17 references) (auth)

15713 ANALYSIS OF THE TIME-DEPENDENT NEUTRON TRANSPORT EQUATION WITH DELAYED NEUTRONS BY THE METHOD OF MATCHED ASYMPTOTIC EXPANSIONS. Hendry, W. L.; Bell, G. I. (Los Alamos Scientific Lab., N. Mex.). Nucl. Sci. Eng., 35: 240-8(Feb. 1969).

The time-dependent neutron transport equation is treated as a problem in singular perturbation theory. The method of matched asymptotic expansions is used to find equations yielding approximate solutions that are uniformly valid in time. The long-time solutions resulting from this method are those of the prompt-jump approximation. Although best suited for fast subcritical systems, numerical results from diffusion theory calculations indicate that very good accuracy is obtained for thermal systems as well. (9 references) (auth)

15714 INSTABILITY BOUNDS IN LINEARLY STABLE SYSTEMS. Shotkin, Louis M. (Brookhaven National Lab., Upton, N. Y.). Nucl. Sci. Eng., 35: 211-19(Feb. 1969).

A general method is presented for determining the bounds on allowable disturbances, in linearly stable systems, for which the system remains asymptotically stable. It is based on transforming a set of nonlinear differential equations to a single equation that is valid within a given region of equilibrium. It is applicable to systems with a fairly general nonlinear feedback as well as to systems that exhibit finite escape time, thus extending previous methods. The physics enters through the linear characteristic roots, and provision is made for both real and complex roots. The method is also of use in determining the range of validity of space-independent reactor models. Applications are given to

three examples of reactor systems, including the determination of reactor excursions. (15 references) (auth)

15715 CALCULATION OF TWO-DIMENSIONAL REACTORS BY MULTIGROUP EIGENFUNCTION METHOD. Kolosov, B. I.; Nikolaishvili, Sh. S. At. Energ. (USSR), 26: 64-6(Jan. 1969). (In Russian).

A method of multigroup proper functions was developed for calculating physics parameters of two-dimensional nuclear reactors. A numerical example was given for two-group diffusion approximation of a slab reactor with lower front reflector and partially submerged absorption in the slab. The tabulated data include comparative results of calculations of the highest proper number λ for the developed equations where λ is the proper number calculated with conservation of two terms according to the developed equation curves developed for the distribution of fast and thermal neutrons as a function of coordinate Y in various cross sections of a slab reactor calculated according to the proper functions showed good agreement with the precise integral and differential calculations obtained by multigroup proper functions. (R.V.J.)

15716 INTEGRATED ANALYTICAL MODEL FOR THE EVALUATION OF TWO-PHASE FLOW STABILITY. Kjaer-Pedersen, Niels (General Electric Co., San Jose, Calif.). Nucl. Sci. Eng., 35: 200-10(Feb. 1969).

The problem of self-sustained hydrodynamic oscillations of a two-phase fluid traveling in a single heated channel is described. A physically adequate analytical model of this often discussed phenomenon that is simple enough to provide some understanding of the driving mechanisms and to permit immediate conclusions as to the bearing on system stability of several important design and operational parameters is studied. For this reason, it was decided to avoid conventional transfer-function description, which could have provided somewhat greater accuracy. An instructive stability plot that permits a quick survey over the stability properties of a given system is introduced. However, it has also been shown that the integrated or point model is not adequate for all cases. Hence, a modification, called the "long channel correction," that successfully substitutes a spatial analysis whenever necessary is introduced. Stability plots are obtained that clearly display the difference between the predictions of the model without the long channel correction (the simple model) and the model with the long channel correction. Comparisons have been made to experimental data as well as to the predictions of a stability code with a detailed spatial description. Good agreement has been demonstrated for the model with the long channel correction. The existence of a crucial boiling length or point of minimum stability is confirmed by the corrected model but not by the simple model. Moreover, it appears that the point of minimum stability is closely related to the point where the long channel correction becomes important. In other words, as subcooling is decreased, the increasing importance of the time delays in the system gives rise to an inversion of the stability trend and, at the same time, the point-model description becomes insufficient. The present model is expected to find application in cases where a quick survey of the stability trends of a group of systems is more important than accurate predictions for one particular situation. 9 references. (auth)

15717 EFFECT OF LINEARLY ANISOTROPIC NEUTRON SCATTERING ON DISADVANTAGE FACTOR CALCULATIONS. Bond, G. R.; Siewert, C. E. (North Carolina State Univ., Raleigh). Nucl. Sci. Eng., 35: 277-82(Feb. 1969).

An expression for the disadvantage factor for a two-region heterogeneous cell in plane geometry has been obtained within the structure of one-speed neutron transport theory. The scattering in the fuel region has been assumed isotropic; however, to describe more accurately the scattering in the moderator, a two-term kernel has been used. The analysis is based on Case's normal-mode expansion technique and leads to a set of Fredholm equations for the unknown expansion coefficients. Numerical solutions, obtained by solving iteratively the Fredholm equations for the expansion coefficients, are given for several sets of parameters. 14 references. (auth)

15718 METHOD FOR TREATING THE NEUTRON LEAKAGE IN SMALL EXPONENTIAL CORES. Ludewig, Hans (Brookhaven National Lab., Upton, N. Y.). Nucl. Sci. Eng., 35: 289-95(Feb. 1969).

The principal object of an exponential experiment is the determination of the material buckling for a particular reactor configuration. To obtain more accurate results for flux leakage effects in small cores, the flux is assumed to decay exponentially in the axial direction. By comparing the solutions resulting from the transport theory model to solutions obtained by diffusion theory, an attempt is made to correct the radial leakage in diffusion theory by defining new diffusion constants. 14 references. (D.C.C.)

15719 MEASUREMENT OF THE THERMAL-NEUTRON EXTRAPOLATION LENGTH IN A PULSED WATER SYSTEM. Shalev, S.; Shani, G.; Fishelson, Z.; Ronen, Y. (Technion-Israel Inst. of Tech., Haifa). Nucl. Sci. Eng., 35: 259-66(Feb. 1969).

As part of a comprehensive project to investigate the validity of pulsed-neutron measurements in small systems, the extrapolation length in a pulsed light-water system with $B^2 = 0.11/cm^2$ was measured. Space- and time-dependent flux distributions were obtained with a miniature fission chamber and were analyzed by least-squares techniques. Special attention was paid to the extraction of the fundamental mode and to the overall internal consistency of the results. The thermal neutron extrapolation length, corrected to 20°C, was found to be 0.300 ± 0.015 cm. 27 references. (auth)

15720 A NONLINEAR XENON STABILITY CRITERION FOR A SPATIALLY DEPENDENT REACTOR MODEL. Stacey, Weston M, Jr. (General Electric Co., Schenectady, N. Y.). Nucl. Sci. Eng., 35: 395-6(Mar. 1969).

Previous work by C. Hsu in which generalized Lyapunov methods were applied to the stability analysis of spatially dependent nuclear reactor models is extended to the xenon instability problem. A nonlinear stability criterion is derived for a spatially dependent model which is assumed to be linearly stable. (H.D.R.)

15721 SPACE-TIME KINETICS FOR HETEROGENEOUS REACTOR MODELS. Saji, Genn; Axford, Roy A. (Univ. of Illinois, Urbana). Nucl. Sci. Eng., 35: 319-31(Mar. 1969).

A new theoretical formalism of the space-time kinetics is developed for heterogeneous reactor models. The basic time-dependent diffusion equation, which contains terms representing localized absorption and fast-neutron production by fuel rods, is analytically transformed into a convolution integral form. This enables computation of space- and time-dependent flux for heterogeneous reactors by considering the sizes and spacings of the fuel rods, their geometrical locations, and the nuclear properties of the material used. Although the basic idea and mathematical formalism developed can be applied for various other space-time kinetics problems, the final calculation is performed for the forced oscillation problem. The computer codes, HERMITS-1 and HERMITS-2, are developed. By using these codes, it is shown that contour maps of the static flux, phase angles, and amplitudes of neutron waves around the fuel rods can be calculated in an extremely short amount of machine time. 22 references. (auth)

15722 AXIAL PROPAGATION OF NEUTRON WAVES IN HETEROGENEOUS MEDIA. Quddus, M. A.; Cochran, R. G.; Emon, D. E. (Texas A and M Univ., College Station). Nucl. Sci. Eng., 35: 342-9(Mar. 1969).

A theoretical study of the axial propagation of plane-thermal-neutron waves in a heterogeneous system is performed in the framework of the P-1 approximation to the Boltzmann equation. The method is based on a modified form of heterogeneous reactor theory due to Feinberg and Galanin. The analysis predicts that the phase interference between the modes of propagation in the axial direction may give rise to resonances in the frequency response of the asymptotic moderator flux. A standing wave pattern is also predicted in the amplitude distribution of the oscillating part of the moderator flux in the axial direction. The relationships between the resonances and the system parameters are investigated. An experimental method that can be useful for the determination of the effective values of the diffusion parameters and the slowing down time is suggested. Numerical calculations for a heavy-water-moderated natural uranium system containing four identical fuel rods are presented in the frequency range from 0 to 1500 Hz. Two resonances are predicted in the transfer function of such a system in this frequency range. A comparison is made with the experimental results published in the literature for a similar system. The complex relaxation length for this system is also calculated numerically in order to study the effect of the resonances in the transfer function on the complex relaxation length. The results show existence of "loops" in the plot of the complex relaxation length. 14 references. (auth)

15723 CRITICALITY CONTROL: INEVITABLE IN WORK WITH FISSILE MATERIALS. Suhr, Per B. (Danish Atomic Energy Commission, Risoe). Forsk. Udvikling-Uddannelse (Copenhagen), 77: 221-5(1968). (In Danish).

An introduction is given to the concepts criticality and criticality control. Fissile and fertile materials, chain reaction and critical mass are defined, and the influence of hydrogen on the critical mass of ^{235}U is dealt with. Two-group diffusion theory is briefly described as an example of calculation technique, and sections on criticality accidents, criticality control and criticality alarm follow. The principles of criticality control applied

at the DAEC are described and illustrated by an example. (auth) (Denmark)

15724 VARIANCES AND COVARIANCES OF NEUTRON AND PRECURSOR POPULATIONS IN TIME-VARYING REACTORS. Clarke, W. G.; Harris, D. R.; Natelson, M.; Walter, J. F. (Bettis Atomic Power Lab., West Mifflin, Pa.). Nucl. Sci. Eng., 31: 440-57(1968). (WAPD-T-1897).

The fluctuating populations of particles in a reactor are described in usual kinetics studies by the numbers of neutrons and precursors which, in the absence of feedback mechanisms, can be identified with first moments of the population distributions. At a higher level of description, variances and covariances of the neutron and precursor populations are determined from equations similar to the first-moment equations. The behavior of these first and second moments for time-varying reactors is explored analytically and numerically, and inferences are made as to the effect of initial reactor conditions and modes of reactivity change on this dynamic behavior. 11 references. (auth)

Experimental Applications

Refer also to abstracts 15333 and 15338.

15725 (ANS-RPD-1) PROCEEDINGS OF THE SPECIAL SESSIONS ON RESONANCE CROSS SECTIONS IN THE UNRESOLVED RESONANCE REGION AND APPLICATION OF MONTE CARLO TECHNIQUES TO REACTOR PHYSICS, PRESENTED AT THE 1968 SUMMER MEETING OF THE AMERICAN NUCLEAR SOCIETY AND THE CANADIAN NUCLEAR ASSOCIATION, TORONTO, CANADA, JUNE 10, 1968. Fullwood, R. R. (comp.) (American Nuclear Society, Hinsdale, Ill. Canadian Nuclear Association, Toronto (Ontario)). 195p. Dep. CFSTI.

Ten papers from the special sessions, sponsored by the American Nuclear Society-Reactor Physics Division, at the 1968 Summer meeting in Toronto are included. Separate abstracts are prepared for each of the ten papers. (M.L.S.)

For abstracts of individual papers see: 15672 and 15726–15734.

15726 (ANS-RPD-1, Paper 1) UNRESOLVED RESONANCE REGION CROSS SECTIONS AND REACTOR CALCULATIONS. Russell, John L. Jr. (Gulf General Atomic, Inc., San Diego, Calif.). 14p. (CONF-680601-55).

Effects of scattering resonances in the unresolved region are considered from the view of their effects on reactor calculations. Methods of treating resonance data for some heavy metals are described; accuracy of calculational techniques is evaluated; methods for measuring resonance data are analysed. Results of comparisons of experiment and theory are shown graphically. 11 references. (M.L.S.)

15727 (ANS-RPD-1, Paper 2) STATISTICAL TREATMENT OF RESONANCE ABSORPTION IN THE UNRESOLVED RESONANCE REGION. Dyos, M. W. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). 18p. (CONF-680601-48).

A statistical method for calculating resonance absorption in the unresolved resonance region is given. Statistical methods are reviewed; the validity of distribution functions for the resonance parameters is assessed. Results of the calculations are discussed. Values for resonance integrals are tabulated; $\bar{\alpha}$ (0.29–10 keV) for ^{239}Pu is shown as a function of $\bar{\Gamma}_f^{J\pi}(E = 0)$. 15 references. (M.L.S.)

15728 (ANS-RPD-1, Paper 2A) APPLICATION OF MONTE CARLO METHODS IN REACTOR PHYSICS. Mendelson, M. R. (Knolls Atomic Power Lab., Schenectady, N. Y.). 24p. (CONF-680601-51).

A description of the Monte Carlo computer codes used for reactor physics calculations is given. The uses of Monte Carlo methods as analytical tools and for simulation of idealized experiments are discussed. Development of the two-dimensional multigroup theory code IT is used to illustrate code development; methods for assessing accuracy of codes are summarized. Capabilities of the DRAM and MORSE codes are compared; comparisons of DRAM-simulated data and experimental data are tabulated. (M.L.S.)

15729 (ANS-RPD-1, Paper 3) NEUTRON CROSS-SECTION MEASUREMENTS SPANNING THE RESOLVED-TO-THE-UNRESOLVED RESONANCE REGION. Block, Robert C. (Rensslear Polytechnic Inst., Troy, N. Y.). 20p. (CONF-680601-46).

The resolved and unresolved resonance region is defined from an experimentalist's point of view; energy level and neutron energy resolution diagrams are shown. Capture cross section measurements for ^{183}W are plotted as capture yield vs. neutron-time-of-flight; ^{183}W transmission is shown, also, as a function of neutron-time-of-flight. A comparison of the measurement techniques of the pulsed white source of neutrons and neutron-time-of-flight is given; use of these techniques in resolved and unresolved resonance regions are considered briefly. The s and p wave components of the neutron capture cross section are shown as a function of energy. Spin state assignments for ^{239}Pu are tabulated. 13 references. (M.L.S.)

15730 (ANS-RPD-1, Paper 3A) APPLICATIONS OF MONTE CARLO TO PROBLEMS IN REACTOR DESIGN AND EXPERIMENTAL ANALYSIS. Levitt, Leo B. (Atomics International, Canoga Park, Calif.). 14p. (CONF-680601-50).

Application of the Monte Carlo method to fuel cell configurations for the HWOCR is discussed. Relative power calculations are shown for various types of HWOCR fuel element bundles. Core neutronics parameters calculated by the HWOCR-SAFE program are tabulated for actual and HAMMER geometries. Application of the backward random walk principle to reaction rate determination is discussed. Adjoint mode sampling techniques are described; difficulties in adjoint Monte Carlo sampling arising from reversal of kernel arguments are detailed. The use of a biased adjoint scattering kernel is described; equations for weight factors for adjoint Monte Carlo applications are given. (M.L.S.)

15731 (ANS-RPD-1, Paper 4) INTERFERING RESONANCES. Moldauer, P. A. (Argonne National Lab., Ill.). 16p. (CONF-680601-52).

Elements for which resonance interference becomes the dominant feature in cross section behavior are listed. Characteristics of isolated resonances are reviewed; statistics of isolated resonance parameters are summarised. Statistics of resonance pole parameters for interfering resonances are discussed. Properties of the interfering resonance poles are determined; these are compared to non-interfering resonance poles. Pole statistics are detailed; examples of calculations are shown graphically. Results of S-matrix and statistical model calculations are shown. (M.L.S.)

15732 (ANS-RPD-1, Paper 4A) DEVELOPMENT AND USE OF MONTE CARLO TECHNIQUES IN REACTOR DESIGN AT UNITED NUCLEAR CORPORATION. Nakache, F. R. (United Nuclear Corp., Elmsford, N. Y. Research and Engineering Center). 23p. (CONF-680601-53).

Use of Monte Carlo programs for evaluation of neutronics characteristics of boiling and pressure water reactor fuel assemblies is discussed. Programs used to prepare or process neutron cross section input data are listed; each is described briefly. A general description of reactivity Monte Carlo programs is given; a PILE flow diagram is included. Application of the computer programs to fuel assemblies for boiling and pressurized reactors is discussed. Comparison of measured neutron multiplication factor values and THERMOPILE-PILE data are tabulated; measurements were made on boiling water reactor fuel assemblies in the Pawling Lattice Test Rig. Design parameters for the fuel assemblies are given. Errors between measured and calculated values are analysed. Solution of diffusion problems by Monte Carlo methods is discussed; a two-dimensional floating random walk method is described. 11 references. (M.L.S.)

15733 (ANS-RPD-1, Paper 5A) APPLICATION OF MONTE CARLO TO NEUTRON TRANSPORT AND REACTOR ANALYSIS PROBLEMS AT THE EURATOM RESEARCH CENTER, ISPRA. Rief, H. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 19p. (CONF-680601-54).

The TIMOC code for Monte Carlo fast reactor physics calculations is described. Three relatively unique features of the TIMOC code are: calculation of small reactivity effects in a complicated three dimensional geometry, sampling of time eigenvalues, and effective variance technique for treating time dependent neutron migration in small systems; each of these is discussed. Reactivity and neutron generation times, calculated by TIMOC, are tabulated for SORA; the model used for the calculations is described; time eigenvalues are tabulated. Application of the TIMOC code to time dependent neutron migration studies is discussed. 14 references. (M.L.S.)

15734 (ANS-RPD-1, Paper 6) RESONANCE PARAMETER DISTRIBUTIONS FOR INTERFERING RESONANCES. Freeman, R. A. (San Diego State Coll., Calif.); Garrison, J. D. (Gulf General Atomic Inc., San Diego, Calif. San Diego State Coll., Calif.). 19p. (CONF-680601-49).

The distributions of Kapur–Peierls or Humblet–Rosenfeld resonance parameters and spacings for a variety of interference conditions have been obtained by Monte Carlo calculations in the two-resonance approximation using the distribution of R-matrix resonance parameters and spacings and the mathematical

connection between the R-matrix and Kapur–Peierls cross section formulations. The R-matrix distributions are assumed the same under all conditions of interference. (auth)

15735 ANALYSIS OF THE DIEAWAY OF PROMPT NEUTRONS WITH TWO-GROUP TIME-DEPENDENT DIFFUSION EQUATION IN REFLECTED REACTORS. Karam, R. A. (Argonne National Lab., Ill.). Nucl. Sci. Eng., 35: 285-9(Feb. 1969).

Eigenvalue determination for a three region reactor using the two-group time dependent diffusion equation is discussed. ZPR-9 experiments for measuring time dependence of the prompt neutron chain are described. Atom densities and core diagrams are given for ZPR-9, Assemblies 6 and 7. Results of correlated counts/channel opening are given as a function of time and of channel number. Prompt neutron decay constants and two-group macroscopic cross sections are tabulated for ZPR-9 Assemblies 6 and 7; neutron currents at core-reflector interface are shown. (M.L.S.)

15736 REACTOR-NOISE ANALYSIS: THE COVARIANCE METHOD VIA POLARITY DETECTION. Pacilio, Nicola (Argonne National Lab., Ill.). Nucl. Sci. Eng., 35: 249-58(Feb. 1969).

A method is proposed for measuring the prompt decay eigenvalue of the neutron population. It is based on the determination of the covariance of the integrated outputs from two neutron detectors placed in a nuclear reactor, for different values of the integration time interval. The covariance is measured by an analysis of the four types of combined outputs which can occur if only the sign of the signal with respect to its mean is recorded from each detector. In fact, the frequence of every combination assumes a different value according to the degree of coherence between the two detector counting outputs. The method allows experiments to be made with low-detection efficiency and can be applied also to fast reactor-noise analysis, unlike all the other variance-type procedures. Since the detection of only the sign of the variables is needed, a pulse counter is not indispensable and, therefore, the technique is expected to be applicable even to nonzero power reactors. (12 references) (auth)

Reactor Components, Fuels, and Accessories

Refer also to abstracts 12917, 13921, 13922, 13942, 13970, 14082, 14108, 14317, 14352, 14374, 14383, 14385, 14416, 14417, and 15772.

15737 (ANL-7411(Suppl.1)) ARGONNE CODE CENTER: COMPILATION OF PROGRAM ABSTRACTS. Supplement 1. Butler, M. K.; Legan, Marianne; Ranzini, L. (Argonne National Lab., Ill.). Oct. 1968. Contract W-31-109-eng-38. 260p. Dep. CFSTI.

A bibliography of computer program abstracts referring to available computer programs at the Argonne Code Center is presented. (D.C.C.)

15738 (BNWL-963) PLUTONIUM UTILIZATION PROGRAM. Technical Activities Quarterly Report, September–November 1968. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan. 1969. Contract AT(45-1)-1830. 89p. Dep. CFSTI.

CRITICALITY STUDIES—critical masses and bucklings of water-moderated plutonium oxide (PuO_2)–uranium oxide (UO_2) lattices
DEUTERIUM—content in PRTR irradiated Zircaloy-2 pressure tubes
HYDROGEN—content in PRTR irradiated Zircaloy-2 pressure tubes
NEUTRONS, EPITHERMAL—capture in uranium-238, ratio of thermal to
NEUTRONS, THERMAL—capture in uranium-238, ratio of epithermal to
PHYSICAL CONSTANTS TESTING REACTOR—neutronic parameters in water-moderated plutonium oxide (PuO_2)–uranium oxide (UO_2) lattice in, measurement of microscopic
PLUTONIUM OXIDES PuO_2—PuO_2–UO_2, fuels of, effects of specific power and burnup on defect behavior of vibrationally compacted
—gamma dose rate buildup on high exposure samples of
PLUTONIUM RECYCLE CRITICAL FACILITY—multiplication factors for Batch Core fueled, effective, (E/T)
—reactivity coefficients for 13-element core in, moderator level, (E/T)
—fuel cell thermal reaction rate traverse in, (E/T)
—kinetic parameters of 7- and 13-element cores in, (E/T)
PLUTONIUM RECYCLE TEST REACTOR—fuel element testing in, status of high power density plutonium oxide (PuO_2)–uranium oxide (UO_2)
—fuel burnup calculations for Batch Core Experiment
—operations summary for Sept. to Nov. 1968
—pressure tubes in, hydrogen and deuterium content in irradiated Zircaloy-2
—pressure tubes of, crack propagation characteristics of irradiated Zircaloy-2
RADIATION DETECTORS, FISSION FOIL—neutron flux peaking and dipping in particle size, correction method for
REACTOR FUEL ELEMENTS—defect behavior of vibrationally compacted plutonium oxide (PuO_2)–uranium oxide (UO_2), effects of specific power burnup on
URANIUM-238—neutron capture in, ratio of epithermal to thermal, (E/T)
URANIUM OXIDES UO_2—PuO_2–UO_2, fuels of, effects of specific power and burnup on defect behavior of vibrationally compacted
ZIRCALOY-2—hydrogen content in PRTR irradiated pressure tubes of
—crack propagation characteristics of PRTR irradiated pressure tubes of (H.D.R.)

15739 (ORNL-TM-2390) DESIGN AND FEASIBILITY STUDY OF A LARGE-SCALE TEST SIMULATING THE TIME-DEPENDENT BEHAVIOR OF A PRESTRESSED CONCRETE REACTOR VESSEL. Corum, J. M.; Goodpasture, D. W. (Oak Ridge National Lab., Tenn.). Feb. 1969. Contract W-7405-eng-26. 88p. Dep. CFSTI.

To provide a basis for evaluating the feasibility and desirability, as well as the cost, of performing a large-scale thermal test, a design study was carried out based on a thick-walled cylinder test specimen, representing a segment out of the cylindrical portion of a cylindrical concrete vessel. The specimen chosen is 15 ft 9 in. high and 27 ft in outside diameter with a wall thickness of 6 ft. The structure is post-tensioned with the Stressteel-S.E.E.E. strand system in the axial and circumferential directions. The inside surface is provided with a $\frac{1}{2}$-in.-thick steel liner together with a means of applying an internal hydraulic pressure of 700 psi. Embedded electrical heaters are provided to simulate thermal conditions. The test specimen, together with the necessary instrumentation and controls system, would be housed in a special building with a controlled environment of 70°F and 50% relative humidity. The specimen would be instrumented with a total of 330 embedded vibrating wire strain gages, bonded resistance surface strain gages, embedded stress gages, tendon load transducers, thermocouples, moisture gages, and deflection gages. A $3\frac{1}{2}$-year test program is outlined. The total cost for providing the test structure together with the necessary facilities, instrumentation, and controls, ready for testing, is estimated to be $948,000. It is concluded that the preliminary design presented is feasible and would provide the necessary information, provided that adequate and reliable instrumentation is utilized. 38 references. (auth)

15740 METHOD OF AND APPARATUS FOR LOCATING ENVELOPE-TUBE DAMAGE AT INDIVIDUAL NUCLEAR FUEL ELEMENTS IN A REACTOR CORE. Holzer, Rolf; Stehle, Heinz; Schubert, Franz; Weber, Robert; Klar, Erich (to Siemens Aktiengesellschaft). U. S. Patent 3,419,467. Dec. 31, 1968. Priority date Mar. 31, 1965, Germany.

Method of locating envelope-tube damage of individual nuclear fuel elements in a reactor core includes coarsely checking respective multi-element regions of the core for occurrence of damage to thus detect any suspicious core region, individually and sequentially removing the fuel elements from the suspicious region and inserting them into a pressure vessel for testing the respective fuel elements, rinsing each element in the testing vessel with water and repeatedly changing pressure and temperature of the water in the testing vessel and measuring the concentration of fission products contained in the water. Apparatus for carrying out the above-mentioned method includes means for repeatedly changing the pressure and temperature of the water in the testing vessel. (Offic. Gaz.)

15741 NUCLEAR FUEL ELEMENT. Ishikawa, Kiyoshi (to Hitachi Ltd.). Japanese Patent 1968-21271. Sept. 6, 1968. Filed Jan. 23, 1965.

The method proposed has the following advantages: easy construction; low cost; improved neutron economy. Axial fuel rods are placed in the element container, fixed both at the top and the bottom. Along the length of the fuel rods spacers are used to maintain constant separation. The spacer is a short cylinder, cut axially at one end into four parts with each part bent outward. This

spacer is fixed around a fuel rod after insertion. By this means, the desired spacing is achieved. (NSA of Japan)

15742 METHOD OF REMOVING HEAT FROM A REACTOR. Torikai, Kinichi (to Japan Atomic Energy Research Inst.). Japanese Patent 1968-24836. Oct. 26, 1968. Filed Nov. 12, 1965.

By the method proposed, the heat removal can be changed according to the rate of heat output throughout the volume of a reactor core. Fuel plates and their support plates which are vertical, are arranged alternately, forming the corresponding thick plate; these plates are placed in the reactor core with some space between. Horizontal grooves whose size and number differ according to the rate of heat output are made on the joining surface of the fuel boards. Cooling fluid runs through the vertical spaces and the horizontal grooves in the reactor core. (NSA of Japan)

15743 HYPERFINE STRUCTURE OF THE THERMAL SPECTRUM INDEX ACROSS COMPLEX-GEOMETRY FUEL ELEMENTS. Guardini, S.; Tassan, S. (EURATOM-CCR, Ispra, Italy). Energ. Nucl. (Milan), 16: No. 2, 30-4(Feb. 1969).

A measurement of the hyperfine structure of the thermal spectral index across cluster-type fuel elements in a heavy water moderated lattice is performed by activation of the ^{176}Lu-^{164}Dy detectors pair. The usefulness of a technique using Lu-Dy miniature detectors for the detailed mapping of the thermal spectral index in well-thermalized reactor lattices of complex-geometry fuel elements is investigated. (8 references) (auth)

15744 SURVEY OF PUBLIC OPINION ON THE PEACEFUL USE OF ATOMIC ENERGY. Genshiryoku Iinkai Geppo, 13: No. 8, 17-23(Aug. 1968). (In Japanese).

The concern about the peaceful use of atomic energy is described. A survey of 3000 men and women of 20 years of age and older extracted at random is presented. Results are described. (NSA of Japan)

15745 LOCAL IN-CORE POWER MEASUREMENTS WITH OUT-OF-CORE GAMMA DETECTORS. Kenney, E. S.; Schultz, M. A. (Pennsylvania State Univ., University Park). Nucl. Appl., 6: 238-40(Mar. 1969).

Preliminary measurements were made of local power level inside a reactor core using two collimated gamma ray beams containing reactivity induced noise information. A conventional two-input correlator was used for the electronics. The results indicate that power distribution in a reactor probably could be obtained to a core depth of ~10 cm with simple detecting apparatus mounted external to the core. A plot obtained with correlated gamma rays closely resembled one obtained by conventional cobalt wire neutron activation. (auth)

15746 HIGH-TEMPERATURE HEAT CARRIER (D.M.D.). Grislis, V. Ya.; Plaude, K. K. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser., No. 6, 83-4(1968). (In Russian).

Analysis of thermo-physical properties of organic coolant diphenylmethane–biphenyl (DMD) showed that an eutectic mixture of DMD $C_{12}H_{10}-C_{13}H_{12}$ could be considered as future coolant material in nuclear reactors. The coolant did not exhibit any residual radioactivity when tested in the Latvian nuclear reactor. (R.V.J.)

15747 METHOD AND DEVICE FOR THE SUPERVISION OF INSTALLATIONS, IN PARTICULAR SAFETY SWITCHING SYSTEM OF NUCLEAR REACTORS. Oehmann, Manfred (to Gesellschaft fuer Kernforschung mbH). U. S. Patent 3,424,652. Jan. 28 1969. Filed Apr. 26, 1966.

Safety system for supervising installations, including multiple separate safety channels having test signal generators, test signal receivers, means for producing output test signals from the system being monitored, means for comparing the input and output test signals to produce a composite disturbance signal, means for producing a correction signal responsive to the disturbance signal, and means responsive to the correction signal whereby correction of a defect or error resulting in the disturbance signal is automatically eliminated is described. The system is an m-out-of-n system which automatically converts to a p-out-of-q system upon an error being present, and which operates in such a manner that the self-repair time is shorter than the minimum permissible monitoring off-line time of the system. (Offic. Gaz.)

15748 COMPUTER PROGRAM FOR CALCULATION OF PRESSURE VESSELS. Olsen, B. E.; Killerud, Kai (Institutt for Atomenergi, Kjeller, Norway). Maskin; Tidsskr. Maskin- Verkstedtek., 1: 186-91(Nov. 1968). (In Norwegian).

A computer program for calculation of various types of cylindrical steel pressure vessels is described. The program is designed to facilitate computation of all dimensions which are significant for the strength characteristics of the pressure vessel and thus form the basis for the detailed design. (auth)

15749 NUCLEAR FUEL AND MATERIALS (U, Be, Zr) FOR REACTOR. Mishima, Yoshitsugu (Tokyo Univ.). Kogyo Rea Metaru, No. 39, 19-22(Sept. 1968). (In Japanese).

In the power generation program made public in January 1968, the Japanese nuclear power generating installation would be 6.93 million kw by the end of 1975, and the long term program was advanced in the schedule. Uranium ore was secured as much as 58% of the necessary amount up to 1978. The supply of U used for the Tokai power station and the reproduction of used fuel were guaranteed by Great Britain, and the private ownership of nuclear fuel, the enriching service of 161 tons of U, and the procurement of 365 kg of Pu for the research and development use were guaranteed by U.S.A. In order to prepare for the start of operation of nuclear power plants, the standards related to the transporting vessel for nuclear fuel and the criteria for the various inspections performed by the MITI were drawn up. The qualitative problems of domestically produced fuel for the light water reactors were almost solved. The prototype reactor of the new type conversion reactor with 200,000 kw output was scheduled to reach at the criticality in 1974. In case of the fast breeder reactor, fuel was intended to be produced in Japan, and the research was being set forward. About the beryllium alloy sheath tube, the decline of ductility due to helium damage was analyzed. A 901 kg rectangular bar of Be was used for the reflector in the material testing reactor JMIR. The new technique for separating Zr and Hf was being developed in Nippon Mining Co., Ltd. (NSA of Japan)

15750 IN-CORE MONITOR. Shirayama, Shimpey; Kasai, Makoto (Tokyo Shibaura Electric Co., Ltd.). Toshiba Rebyu, 24: 53-7(Jan. 1969). (In Japanese).

The in-core monitor as a reactor neutron monitoring system possesses the ability of controlling reactors with high accuracy, effecting efficient fuel utilization and safe plant operation. Toshiba, developing a new type of in-core monitor assembly, made its tests by applying it to JPDR with successful results. (NSA of Japan)

15751 DUAL FUEL CYCLE FOR NUCLEAR REACTORS. Graham, R. H.; Fortune, R. F. (to Canadian General Electric Co., Ltd.). Canadian Patent 797,999. Oct. 29, 1968.

A method is described for extending the burnup range of nuclear fuel by first utilizing it in one type of reactor and then in another type for which it is adapted after the initial depletion. Instead of reprocessing the depleted enriched fuel, its further use in reactors designed to accept natural U fuel is proposed. Fuel bundles whose integrity is unimpaired may be transferred directly to the natural U type reactor while others which have suffered sheath defects may require some repair. Accumulated fission gases may be vented by piercing the sheath and then welding the hole again. The U fuel may be in the form of metal, oxide, carbide or nitride. (F.S.A.)

15752 COMMENTS ON A PAPER CONCERNING NEUTRON DIFFUSION IN LIGHT AND HEAVY WATER. Parks, P. B.; Pellarin, D. J.; Baumann, N. P. (Savannah River Lab., Aiken, S. C.). Nucl. Sci. Eng., 35: 412(Mar. 1969).

Neutron diffusion parameters for H_2O are presented for a more restricted inverse diffusion length range than that used in the earlier calculations. (H.D.R.)

15753 SYSTEM FOR FUNCTIONAL SUPERVISION OF HEAT-INSULATING LAYERS IN NUCLEAR REACTOR CHANNELS. Becker, Winfried; Finzi, Sergio; Jorzik, Ernst R.; di Besozzo, Cardanz; Ohlmer, Eggert (to EURATOM). U. S. Patent 3,418,207. Dec. 24, 1968. Priority date June 24, 1965, Germany.

A system for the operational monitoring of thermal insulating layers which are to impede heat transfer from reactor fuel elements to the surrounding channel tubes is described. The device consists of an electric cable in contact with the tube. The cable has temperature dependent impedance. A pulse generator and oscilloscope are connected to the cable to detect hot spots by the principle of reflection. The cable is a two wire cable housed in a channel member opening against the channel tube. Spacers divide the channel member into a series of watertight segments. (Offic. Gaz.)

GENERAL

15754 (ANL–7497) ARGONNE CODE CENTER: DIRECTORY OF COOPERATING INSTALLATIONS. Butler, M. K.; Legan, Marianne; Lindsay, Ethelyn; Ranzini, L. (Argonne National Lab., Ill.). Oct. 1968. Contract W-31-109-eng-38. 180p. Dep. CFSTI.

A directory of computer facilities and installation representatives with their mailing addresses and telephone numbers for the Argonne Code Center cooperating installations is presented. (W.H.K.)

15755 (FOA–4-4380) LATTICE SYMMETRY CORRECTIONS TO ENERGY-BANDS FROM A SPHERICAL MODEL. II. APPLICATIONS TO ELECTRON GAS AND SOME SIMPLE METALS. Arbman, G. (Forsvarets Forskningsanstalt, Stockholm (Sweden)). Jan. 1969. 38p. Dep.

Symmetry corrections to energy bands obtained from a spherical version of the cellular method were calculated from a variational procedure reported previously. The calculations were performed for general points in reciprocal space for simple cubic, face-centered cubic and body-centered cubic structure. Results are reported for the electron gas and the metals Na, Cs, and Al. The results were compared to those obtained from other experimental and theoretical investigations, and the effects of using different potentials are considered in some detail. It was found that in order to obtain good results, the input data required by the procedure should not deviate substantially from the correct solutions. (auth) (Sweden)

15756 (LA–4020(Suppl.1)) RDTRAN: MACHINE-DEPENDENT MODIFICATIONS FOR THE CDC-6600. McDaniel, Roger D.; Griffin, James H. (Los Alamos Scientific Lab., N. Mex.). Jan. 10, 1969. Contract W-7405-eng-36. 23p. Dep. CFSTI.

RDTRAN is a computer program for translating and processing free-format input data. It is an interpretive system designed for use as the input translator of a problem-oriented source language, or as a general purpose free-format input loader. This is a supplement to LASL report LA-4020 and contains a source language listing of the machine-dependent modifications for the CDC-6600. (auth)

15757 (ORNL–4355) SEQUENTIAL PROCEDURE FOR SELECTING THE POPULATION WITH THE SMALLEST VARIANCE FROM k NORMAL POPULATIONS. Hoel, David G. (Oak Ridge National Lab., Tenn.). Jan. 1969. Contract W-7405-eng-26. 17p. Dep. CFSTI.

A technique is given for the construction of sequential selection procedures which are truncated and fully sequential. The method is applied to the problem of selecting the population with the smallest variance from a set of k normal populations. (auth)

15758 (ORNL-TM–2219) EMISSION AND DECAY OF ORGANIC LIQUIDS UNDER ELECTRON IMPACT. Abu-Zeid, M-E. M.; Christophorou, L. G.; Carter, J. G. (Oak Ridge National Lab., Tenn.). Feb. 1969. Contract W-7405-eng-26. 146p. Dep. CFSTI.

Thesis. Submitted M-E. M. Abu-Zeid to Univ. of Tennessee, Knoxville.

Liquid benzene and liquid benzene and naphthalene derivatives were excited at room temperature with intense electron beams (average energy 4- to 36-keV) and in all cases the scintillation emission was a structureless band attributed to excimers. A detailed comparison of the spectral characteristics of the electron-impact, x-ray, and ultraviolet induced emissions suggested that the emitting species for the organic liquids studied under electron-impact are singlet state excimers, $^1M_f^*$. Ion recombination is believed to be the origin of the excimeric emission under electron bombardment. It was concluded that the emission from organic liquids is strongly dependent upon the mode and intensity of excitation. In six benzene derivatives, in addition to the dominant emission attributed to $^1M_f^*$, a weaker emission band appeared at longer wavelengths than the $^1M_f^*$ band. This latter band may be due to emission from triplet state excimers, $^3M_f^*$. A pulsed-nanosecond electron beam apparatus has been designed and constructed. It allowed for the first time measurements of the lifetime of the emitting species under electron-impact. The lifetimes (in nanoseconds) for liquid benzene, toluene, ethyl benzene, n-propyl benzene, iso-propyl benzene, o-xylene, m-xylene, p-xylene, and mesitylene are 12.3 ± 0.2, 15.65 ± 0.2, 8.56 ± 0.1, 12.56 ± 0.2, 8.73 ± 0.1, 11.71 ± 0.14, 11.13 ± 0.24, 11.9 ± 0.3, and 22.86 ± 0.3, respectively. Also, the lifetimes for liquid 1-methyl naphthalene, 2-ethyl naphthalene, 1,2-dimethyl naphthalene, and 1.6-dimethyl naphthalene are 25.39 ± 0.1, 48.45 ± 0.36, and 35.4 ± 1, respectively. The values for the lifetimes of benzene, toluene, and p-xylene are almost identical with those of $^1M_f^*$ deduced from ultraviolet studies on these systems. This supports the spectroscopic results on the origin of the emission under electron-impact and indicates that singlet state excimers $^1M_f^*$ are immune to ionization quenching, in contrast to the strong quenching of excited monomers $^1M_f^*$. (auth)

15759 (RD/B/N–1202) AN EXPERIMENTAL JUSTIFICATION OF THE PITT [STRESS ANALYSIS] COMPUTER PROGRAM. Walters, D. J. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Dec. 1968. 16p. Dep. CFSTI.

The initial plastic and creep strains in a thick cylinder were predicted by the PITT program and compared with experimentally derived results. The predicted initial plastic strains were within the 20% scatter band shown by the experimental results while, for a given time, creep strain predictions were within ±15% of the measured values. (auth)

15760 (SC-CR–68-3764) PLACEMENT AND PACKAGING OF TWO-DIMENSIONAL OBJECTS ON A PANEL (FINAL REPORT). Whitaker, E. W. (Thomas Bede Foundation, Los Altos, Calif.). Oct. 1968. Contract 47-0102. 28p. Dep. CFSTI.

For Sandia Labs., Albuquerque, N. Mex.

Given a panel or a bulkhead of a configuration described by two circles, a method is described for placing objects so that they are wholly contained on the panel and do not overlap each other. (B.G.D.)

15761 (SC-CR–68-3796) POPULATION DENSITY STUDY. Vandevender, S. G.; Lindberg, R. C. (Dikewood Corp., Albuquerque, N. Mex.). Dec. 1968. Contract 48-6156. 164p. Dep. CFSTI.

For Sandia Labs., Albuquerque, N. Mex.

A system of computer programs used to regiment world population statistics to a well-ordered form, compress the data to allow ready availability of any portion of it, and analyze these data according to population zones is described. The programs are divided into IBM 7090 routines, which accomplish the regimentation; and CDC 3600 routines, which compress and utilize the data. (auth)

15762 (SLAC–94) SPL COMPILER. Ross, Daniel (Stanford Linear Accelerator Center, Calif.). Dec. 1968. Contract AT(04-3)-515. 219p. Dep. CFSTI.

A compiler source language and internal organization are described, which utilize program block structure to provide a virtual memory capability for linked-list hierarchically structured data. A nonprocedural source language notation is introduced, resembling conventional mathematical set notation, for describing the search and selection of the members of subsets of ordered sets. An algorithm is presented for the translation of these statements into conventional compiler loop statements. Some convenience features in compiler source language notation are introduced, including the ability for the compiler to stay in context with the programmer. One partial implementation of the compiler is outlined. (auth)

15763 (TID–3750) BIBLIOGRAPHIES OF ATOMIC ENERGY LITERATURE. Issued or in Progress During the Period, November–December 1968. (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). 6p. Dep. DTIE Free.

A list of forty-one bibliographies of atomic energy literature issued or in progress during the period November–December, 1968 is presented. A report number index is also included. (B.G.D.)

15764 (TID–24781) GROWTH CHARACTERISTICS OF TYPE E CLOSTRIDIUM BOTULINUM IN THE TEMPERATURE RANGE OF 34°F TO 50°F. Annual Report, June 29, 1963–June 28, 1964. (Continental Can Co., Inc., Chicago, Ill. Metal Div. Research and Development). July 14, 1964. Contract AT(11-1)-1183. 106p. Dep. CFSTI.

Preparation and standardization of spore suspensions, toxin assay procedures, and thermal inactivation of Type E toxin are described. Effects of salt concentrations and pH on the outgrowth of Type E spore inocula at various temperatures in laboratory culture media and in haddock and sole were studied. (H.L.W.)

15765 (UCRL–71283) IMPROVED CIRCUIT MODELS FOR INDUCTORS WOUND ON DISSIPATIVE MAGNETIC CORES. Bun-

tenbach, R. W. (California Univ., Livermore. Lawrence Radiation Lab.). Sept. 10, 1968. 37p. (CONF-681041-1). Dep. CFSTI.
From IEEE Asilomar Conference on Circuits and Systems, Monterey, Calif.

An effective method of analysis of magnetic circuits by the ordinary theorems and laws of electric circuit theory is presented. The method is made possible by the introduction of the concepts of magnetic impedance, the gyrator, and nontraditional electric-magnetic parameter analogies. The magnetic impedance of a laminated ferromagnetic core is derived as a function of the material properties, permeability, and resistivity. The magnetic path in a core is shown to behave as a distributed network with properties analogous to those of an electrical RC transmission line. The electrically equivalent circuit is the dual, an LR transmission line. Representative data are presented to show the close agreement between measured parameters and magnetic and electric impedances calculated by the derived expressions. The data also indicate that the impedance nonlinearity of magnetic materials is much less severe than is implied by the B–H curves of those materials. (auth)

15766 (UUIP–608) X-RAY STUDY OF INNER LEVEL SHIFTS AND BAND STRUCTURE OF TiC AND RELATED COMPOUNDS. Ramqvist, Lars; Ekstig, Boerje; Kaellne, Elisabeth; Noreland, Erik; Manne, Rolf (Uppsala Univ. (Sweden). Inst. of Physics). Sept. 1968. 29p. Dep.

New measurements are presented of Ti K-absorption and emission spectra from TiC, TiN, TiO, TiB_2, and Ti. It is shown that in all investigated compounds, the number of Ti3d electrons is lower than in the pure metal. For the three cubic compounds, the order of increasing ionicity is TiO, TiN, TiC. The results are discussed in conjunction with other x-ray and electron spectroscopical investigations and are shown to be in agreement with energy band calculations using the Augmented Plane Wave Method by V. Ern and A. C. Switendick and by J. B. Conklin and D. J. Silversmith. (auth) (Sweden)

15767 (UUIP–610) GENERATION OF HELICON WAVES IN p-PbSe AND In. Hoeglund, Hans; Pettersson, Bertil (Uppsala Univ. (Sweden). Inst. of Physics). Sept. 1968. 12p. Dep.

Helicons were generated in p-PbSe and in In and used to determine the charge densities. The results were found to agree with results obtained by Hall effect measurements for p-PbSe and free electron theory for In. (auth)

15768 (Y–1653) AN EXTENSION OF APT FOR PRODUCING INPUT DATA FOR A FOUR-AXIS FILAMENT WINDER POST-PROCESSOR (UNION CARBIDE APT FILAMENT-WINDING PRE-POSTPROCESSOR: UCAFIP). Bookhart, T. W.; Easterday, R. J. Fowler, A. H.; Miskell, R. V. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Feb. 7, 1969. Contract W-7405-eng-26. 57p. Dep. CFSTI.

Fortran computer routines, which compute a geodesic path on an arbitrary surface of revolution and determine the machine feed-eye positions, have been incorporated into the APT system. The output of these routines is a cutter location tape which is processed by an APT postprocessor to produce a punched tape for a four-axis numerically controlled filament winding machine. (auth)

15769 AGREEMENT BETWEEN THE GOVERNMENT OF THE UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND AND THE GOVERNMENT OF JAPAN FOR CO-OPERATION IN THE PEACEFUL USES OF ATOMIC ENERGY, WITH MEMORANDUM OF UNDERSTANDING. TOKYO, 6th MARCH 1968. CMND. 3853. Treat Series No. 3 (1969). Superseding Japan No. 1 (1968), Cmnd. 3619. London, Her Majesty's Stationery Office, 1969. 30p. 3s.

This agreement entered into force on 15th Oct. 1968. (U.K.)

15770 LICENSING OF RADIOLOGIC TECHNOLOGISTS: A SUMMARY OF THE CURRENT CONTROVERSY. Schaeflein, J. W. (Veterans Administration Hospital, Long Beach, Calif. California Coll. of Medicine, Irvine). Health Phys., 16: 393-9 (Mar. 1969).

It is stated that legislative activity in the U. S. indicates that radiologic technologists will be licensed in the near future, but that it is not sufficient for health physicists, etc., simply to endorse such licensing. It is essential that the legislation shall place the authority for administration of programs with the appropriate State or Federal Health Department. The person responsible for the health and safety of a group should not be a member of the group, so as to avoid safety considerations being made subservient to other primary objectives of the group. An advisory Board is desirable. It has been estimated that upwards of 90% of the dose received by man from man-made sources of ionizing radiation derives from medical exposure, particularly in the U. S., and numerous studies have established that man is frequently subjected to unnecessary radiation exposure while undergoing diagnostic x-ray examinations. The controversy which arises is how can unqualified x-ray technicians be prevented from operating x-ray equipment, and will licensing radiologic technologists provide an effective means of reducing unnecessary exposure to the public from diagnostic x-ray examinations? Facts and arguments are presented. (UK)

15771 THE IONISING RADIATIONS (SEALED SOURCES) REGULATIONS 1969. Draft of Proposed Special Regulations Published Under Section 180 of, and Schedule 4 to, the Factories Act 1961. London, Her Majesty's Stationery Office, 1969. 20p. 2s.

Comprising sections deal with the following: Interpretation of regulations, and general; administration, notifications, and records; basic principles of protection; radiological supervision; medical supervision; organization of work; monitoring; radiography and other processes; x-ray crystallography and spectrometry; measuring and detecting devices and static eliminators; schedule of maximum permissible radiation doses. (UK)

15772 SOME PROBLEMS DERIVED FROM DOMESTIC PRODUCTION OF NUCLEAR FUEL. Seki, Yoshitatsu (Mitsubishi Atomic Power Industries, Inc., Omiya, Japan). Genshiryoku Kogyo, 14: No. 12, 4-7(Dec. 1968). (In Japanese).

Permission for manufacturing nuclear fuels has already been given to two firms in Japan. Also, the civil possession of nuclear fuels is proceeding; from 1970, nuclear fuels will be produced in Japan. Aspects of domestic production to be considered include: small uranium resources in Japan, dependence on the United States for enrichment; small scale of power programs, and the fact that proven nuclear reactors are developed mostly in other countries. Problems in the handling of uranium; problems concerned with the scale of nuclear fuel manufacturing; and problems in manufacturing of nuclear fuels are discussed. (NSA of Japan)

15773 HOW GREAT IS THE NUCLEAR FALLOUT. III. Schabbeck, P. (Kienbaum Unternehmesberatung GmbH; Gummersbach, Ger.). Atomwirt., Atomtech., 13: 584-6(Dec. 1968). (In German).

The influence of the diffusion of nuclear–technical new developments on the internal structure of individual firms is investigated in the last contribution of a series of three articles. The obvious results are changes in the production program with a variety of reactions on manufacture. They entail changes of investment activity, and also changes in the composition of personnel. Particularly high requirements in operational safety, precision, and purity are a feature of nuclear manufacture and applications. As a consequence there are corresponding demands on all occupational groups concerned in these fields. Willingness to work as a team is an important aspect in this area. (auth)

15774 MANDATORY ACT ON THE REORGANISATION OF THE GREEK ATOMIC ENERGY COMMISSION (GAEC). Nucl. Law Bull., No. 2, Suppl., 3-11(Nov. 1968).

15775 SWEDEN: NUCLEAR LIABILITY ACT. Nucl. Law Bull., No. 2, Suppl., 13-27(Nov. 1968).

15776 LEGISLATIVE AND REGULATORY ACTIVITIES. Nucl. Law Bull., No, 2, 6-30(Nov. 1968).

The legislative and regulatory activities of various countries associated with legal aspects of atomic energy are described. The activities described include the following: Belgium—carriage of radioactive materials; Denmark—third party liability; France—third party liability, radiation protection, and Atomic Energy Commission; Germany—general nuclear legislation and radiation protection; Greece—general nuclear legislation; Iceland—radiation protection; Italy—radiation protection and establishment of a ministry for research in science and technology; Portugal—Junta de Energia Nuclear; Spain—general nuclear legislation and third party liability; Sweden—third party liability; Switzerland—radiation protection; United Kingdom—radiation protection; and United States—third party liability. (B.G.D.)

15777 INTERNATIONAL ORGANISATIONS AND AGREEMENTS. Nucl. Law Bull., No. 2, 31-41(Nov. 1968).

The activities and agreements reached associated with the legal aspects of atomic energy of international organizations are discussed. The international organizations were the IAEA, Euratom, and ENEA. (B.G.D.)

15778 ENEA ANALYTICAL STUDY ON NUCLEAR LEGISLATION. Nucl. Law Bull., No. 2, 42-51(Nov. 1968).

An updated version of the ENEA analytical study on nuclear third party liability is presented. (B.G.D.)

15779 TEXTS. Nucl. Law Bull., No. 2, 52-64(Nov. 1968).

Texts written in France and Italy and by the ENEA are presented. These include France — Act Concerning Third Party Liability in the Field of Nuclear Energy, Italy — Bill No. 204 on the Establishment of a National Office for Nuclear Energy (ENEN), and ENEA — Interpretation of the Paris convention — text of the recommendation adopted by the steering committee for nuclear energy at its sessions of 19th October 1967 and 25th April 1968. (B.G.D.)

15780 PROGRESSO ELETTRONICO. ATTI DEL XV CONGRESSO PER L'ELETTRONICA, ROMA, 3–6 APRILE 1968. I CIRCUITI INTEGRATI. (Advance in Electronics. Transactions of the 15th Congress for Electronics, Rome, April 3–6, 1968. The Integrated Circuit). XV Rassegna Internazionale Elettronica, Nucleare e Teleradiocinematografica. Roma, Rassegna Internazionale Elettronica, Nucleare e Teleradiocinematografica, 1968. 683p. (In Italian and English). (CONF-680454).

A separate abstract was prepared for 1 of the 61 papers presented. The remaining 60 papers were not within the scope of NSA. (W.H.K.)

For an abstract of the individual paper see: 14087.